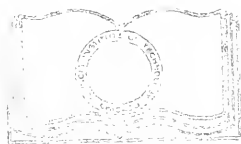


INVESTIGATION OF
THE FLOW OF AIR IN PIPES

BY
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ARMOUR INSTITUTE OF TECHNOLOGY

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INVESTIGATION OF THE FLOW OF AIR IN PIPES

A THESIS

PRESENTED BY

ELMER LUCIUS CANMAN

NORMAN FRANK KIMBALL

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

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BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

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INVESTIGATION
OF
THE FLOW OF AIR IN PIPES

Written and Presented

By

Oliver L. Canman
Norman F. Kimball

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INVESTIGATION OF THE FLOW OF AIR IN PIPES.

The subject of the "Flow of Air in Pipes" has herein been presented together with a brief discussion of the Pitot tube and its application in connection with this treatise.

The Pitot tube is an instrument used for measuring the velocity of fluids in motion. It is simply a tube bent so that a short leg extends into the current of fluid flowing from a tube , with the plane of the entering orifice opposed at right angles to the direction of the current. The pressure caused by the impact of the current is transmitted through the tube to a pressure guage of any kind , such as a column of water or of mercury or a spring gauge. From the pressure thus indicated and the known density and temperature of the flowing gas the head corresponding to the pressure is obtained and from this the velocity. The formula for the Pitot tube is

$$V = \sqrt{2gH}$$

in which

V = velocity of the current in feet per second

H = the head in feet of the fluid corresponding to the pressure measured by the tube.

K = an experimental coefficient.

K = unity when the plane at the point of the tube is exactly at right angles with the direction of the current and when the static pressure is correctly measured.

As early as 1886 Prof. S. W. Robinson made experiments with Pitot tubes to determine the value of the constant K and the variation of this constant with the change in the form of the tip. Prof. Robinson used Pitot tubes of .065 inches , .25 inches , and .4375 inches in diameter with sharp edged tips and found the constant to be practically unity.

Mr. John R. Freeman in 1889 carefully constructed a Pitot tube .006 inches in internal diameter and .017 inches in external diameter with a blunt tip. He used it in the measurement of the velocity of water from a fire engine nozzle under a pressure of fifty pounds per square inch. He found the constant to be unity within one per cent certainly and probably within one quarter

of one per cent.

In 1904 Messrs. Boyd and Judd carried on similar experiments along this same line. The Pitots which they used are shown in Plate . They had their first tubes made out of seamless copper tubing three sixteenths of an inch in outside diameter and one eighth of an inch inside diameter. One of these is shown complete at e and the tips of two others at f and g. The one shown at e had the end finished square , f was bell mouthed and g was tapered on the inside. In each the plane of the tip was made normal to the axis of the end of the tube as nearly as could be determined by a machinist's square. In each case the height of the column connected to the Pitot tube were the same as the static head within .002 feet. Tips a and b were tried with the same results.

They next tried a pair of Pitottubes made of glass tubing .162 inches inside diameter and .206 inches outside diameter. One of these c was made by filing the full size tube as

nearly normal to the axis as possible while for d the tube was drawn down to an outside diameter of .011 inches and .007 inches. These tubes gave exactly the same reading as the static head.

The tube shown at J was made of a brass rod in which a hole .040 inches in diameter was drilled and the end turned to a taper having a very sharp edge at the mouth. This rod was soldered into the end of a piece of three sixteenths inch tubing forming the rest of the Pitot. This tube gave readings .005 of a foot lower than the static head.

The tube shown at h was made of a piece of one sixteenth inch copper tubing of one thirty-second inch bore. This was soldered in a piece of one eighth inch tubing which in turn was fastened to a piece of three sixteenth inch tubing. I was made in the same way but the end was flattened reducing the horizontal inside diameter to .012 inches while the vertical inside

dimension was increased to .047 inches. Both gave readings equal to the static heads. As a result from their experiments Messrs. Boyd and Judd calculated the value of the constant k as .993.

Other experimenters, however, have obtained quite different results. It has been calimed that the pressure in a Pitot tube may be v^2/g instead of $v^2/2g$. The reason for this is found in the fact that a stream of fluid striking a surface sufficiently large to destroy all its motion in the original direction exerts a pressure on the surface equal to v^2/g times the area of the stream. When the area of such a surface is diminished, only a part of the original velocity is destroyed and the total pressure is correspondingly reduced. The change of velocity normal to this surface of the mass of fluid which flows past any section in a unit time, while it forms a part of the column having the surface as its base determines this pressure.

It is easy to see that a continuous stream striking normally on a plane surface equal to its cross section cannot be reflected parallel to that surface for as soon as its normal velocity is diminished its cross section is increased and part of the fluid is pushed out of the column having the surface as its base. Consequently the pressure in a Pitot tube can never be as much as v^2/g

Plate II shows the type of Pitot tube which Mr. D. W. Taylor adopted. It consists of a double tube. The common axis is placed parallel to the direction of the flow of the air or parallel to the center line of the pipe. The outer tube has longitudinal slots in it through which the pressure in the flowing current of air reaches the annular space between the inner and outer tubes. This space being connected with a pressure recording device , the pressure in a moving current of air can be determined. In front of the inner tube the air is brought to rest and the pressure in

this inner tube is also determined by a manometer or pressure recording device.

Mr. W. M. White in an article in the American Machinist states that he has made experiments which settle the dispute relative to the value of the constant k in the formula $v = k \sqrt{2gH}$. He claims that the value of this constant can be taken as unity and dropping of this constant from the formula is perfectly justifiable.

The arrangement of the apparatus as used by Mr. White is shown in Plates III and IV. The Pitot is at a , Figure 1, where it is fitted to the riser pipe b which passes through a stuffing box in the penstock. The inner end of the riser pipe is guided by a cross bar within the penstock and the outer end by supports d and e , which with the inner guides, are at right angles to the axis of the pipe in order that the Pitot tube may be parallel to it. A clamp c permits adjusting the tube to any part of the penstock diameter. Support e is graduated

as shown , the extreme range of graduations being the diameter of the penstock. The graduations increase in fineness as the ends are approached to allow for the increased area value of a given diameter increment near the ends. The upper end of the riser pipe has an air cock f and a rubber tube connection g to the gauge board h , shown in Plate IV. Here also are shown the arrangements for taking the static pressure readings at four points in the circumference of the penstock.

It will be seen that by adjusting the clamp c to the different divisions of its support , the Pitot tube may be set to any point in the diameter of the penstock and the reading can be quickly taken.

In the December 21st 1905 issue of the Engineering News , Mr. R. Burnham , former professor of experimental engineering at the Armour Institute of Technology , describes a Pitot tube used by Messrs. Drefflein and McBurney in a series of experiments.

The tube is shown in Plate V. It consists of two brass tubes , one within the other , the inner tube , three sixteenths of an inch in outside diameter and one thirty-second of an inch thick , forming the velocity tube . The outer or pressure tube is made of three eighths inch tubing , one thirty-second of an inch in thickness , provided with a slot , $1/16$ by $1-1/4$ on the under side of the horizontal portion , for the admission of pressure. Tips of various forms may be attached to the velocity tube , but in the present case the ones shown were used. As a matter of fact it was demonstrated that the form of tip , within quite wide limits , makes no appreciable difference in the indications of the tubes. The pressures exerted were transmitted through rubber tubing , attached at B and G , to opposite sides of sensitive manometers. The arrangement of the tubes in the stuffing box , as shown , permits a longitudinal movement , and also some lateral adjustment , in the event of the hole in the

pipe not being tapped exactly perpendicular to the axis. The position of the tube with reference to the center of the pipe is indicated on a graduated scale , by the pointer T.

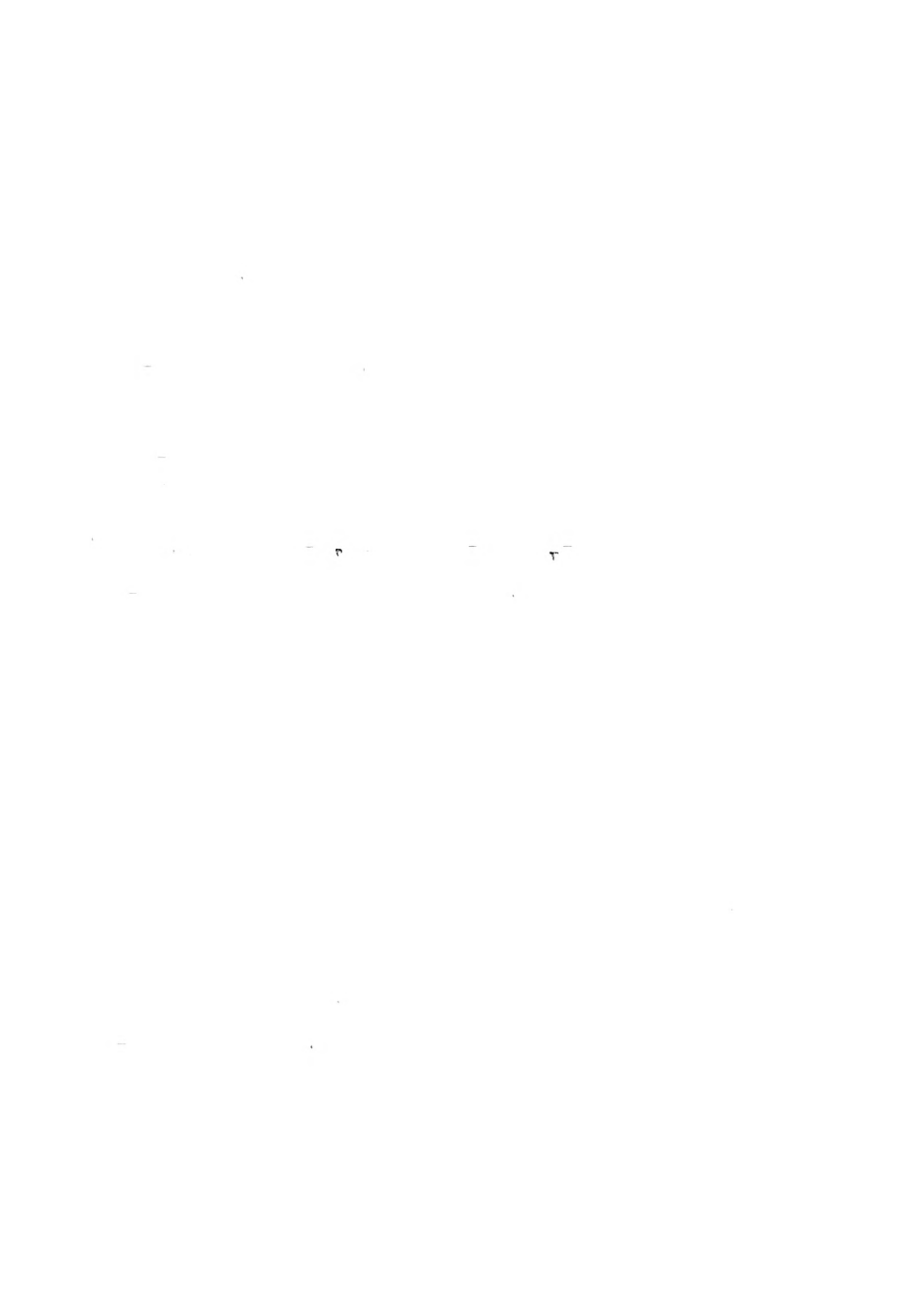
Mr. Burnham also devised the following method for determining the theoretical mean velocity. Referring to Print No 1 let the circle of radius R represent the cross sectional area of the pipe. Construct the right triangle OAB so that the base OB is equal to R and the altitude BA equal to $2\pi R$. This makes the area of the triangle which is πR^2 , equal to the area of the circle. The area of any annular ring of radius r and width dr can be represented as shown by a vertical lamina whose area we obtain by subtracting the area of the circle whose radius is r + dr from the area of the circle whose radius is r. This gives us for the area of the lamina $2\pi r dr$. If the velocity of the gas were the same in all points of the cross section of the pipe the quantity flowing through the pipe in a unit time would be equal to the product of

the area AOB and the velocity. However, the velocity is not uniform and varies with the distance from the center of the circle. Still it may be considered practically the same through a ring whose width is only dr . Hence from calculus we know that we can obtain the volume flowing by taking the summation, throughout the section, of all the products,

$$v' (2\pi r dr + dr^2) + v^2 (2\pi r dr + dr^2) \text{ etc.} = \pi V R^2.$$

where v' , v^2 , etc. are the theoretical velocities as obtained from the Pitot tube readings at radii r and r etc. and V equals the theoretical mean velocity.

This is laid off graphically in the following manner. Lay off these velocities as $v' = BG$ in any convenient scale on the altitude AB. The intersection of OG and the ordinate erected at the extremity of the radius r determines the point P, on the curve OSFR. In a similar manner the other points are found. It can therefore be shown that the quantity of gas flowing per unit of time is proportional to the area



under the curve. The mean velocity is found by constructing the triangle BOF equal to the area under the curve , whence the line BF is proportional to the theoretical mean velocity and the intersection S determines the mean velocity radius. If BE is laid off proportional to the actual mean velocity , as found by dividing the flow in cubic feet per second by the area of the pipe , then BEO/BFO is the value of the constant K in the equation $V = K\sqrt{2gH}$. Since these relations hold whatever scale of units are adopted the H may be plotted instead of the computed velocity.

The following extract was taken from a paper read before the American Society of Mechanical Engineers by Mr. Frank H. Kneeland.

"To obtain the average velocity existing in a pipe from the use of a Pitot tube , recourse may be made to two methods. The first of these is to divide the diameter of the pipe into a given number of equal parts and take one or more readings at each division point. The average velocity would then be considered as the average



of the different velocities obtained at the several points of division. It will be readily seen that this average is not strictly true , since the outer rings of the cross section are of equal width with the inner ones , consequently, they are unequal in area , yet all were given equal weight in calculations. The second , and better method , is to divide the cross section of the pipe into a given number of equal areas and place the dynamic nozzle of the tube in the center of gravity , so to speak, of the circle to be tested".

Messrs. Williams , Hubbell , and Fehkell used the Pitot tube in experimenting with the flow of water pipes. The tubes which they used are shown in Plates VI , VII , and VIII. Tube No 1 was made of brass and was the first one built. It was used in some preliminary investigations upon a twelve inch pipe. Tube No 2 was made from No 1 by measuring the size of the interior pipe connecting to the pressure opening to avoid the possibility of the loss of

head in the small internal pipe affecting the reading of the gauge. Both these tubes had , as shown , a single pressure opening in the bottom.

Although the results obtained from these tubes were very satisfactory , it was thought that better results could be obtained with the form represented by No 3. In this tube there were four pressure openings located ninety degrees apart and forty-five degrees from the knife edge , around the sides of the bulb in the point of which was the impact opening. The bulb formed an equalizing chamber to the four pressure openings.

Tube No 5 was made from Tube No 2 by plugging the original pressure opening and drilling , at right angles to its axis and to that of the impact opening , a hole entirely across the instrument connecting with the original pressure tube , and filing away the heel of the instrument.

Tubes A, B, and C were as nearly alike as a skilled workman could make them. Tube D was

was built for use in a very small pipe and it is quite similar to Tube No 5 , except that its lines are finer and the impact opening cuts away the knife edge , causing it to appear notched in the side view. It also has a downstream opening which was not used. Tube E was designed for similar use , and contains only an impact opening , the pressures being supplied from piezometers in the side of the pipe. Its impact opening is very similar to those of Tubes A, B, and C but very much smaller.

In conducting this experiment the apparatus was set up as shown in Plates X and XI. The source of air supply was a motor driven centrifugal blower with a duct sixteen feet long and twelve inches in diameter. To insure constant speed of the blower , a voltmeter and a carbon plate rheostat were inserted across the main line to the motor , and by regulating the resistance constant voltage was maintained. The blower was driven at four speeds for each pipe respectively , starting with a low speed , then two

intermediate , and lastly the maximum speed which the motor was capable of driving it.

The pipes , of which there were eleven , ranged in diameters from two and one half inches to eleven inches and were symmetrical with respect to length and location of Pitot and static pressure tubes. Each of the pipes was equipped with a flange F and static pressure tube T as shown on Print No 2. A cross section of this flange is shown in Print No 3 and a cross section of the static tube in Print No 4.

It is easily understood from Print No 4 how the average static pressure is obtained. A is a copper tube of about one eighth of an inch in internal diameter and soldered to the pipe in the four places as shown by the light portions near the arrows. Through the pipe , solder , and the inner side of the tube were drilled four small holes and through these holes the pressure was transmitted to the nozzle N. A rubber tube connected this nozzle to an Ellison Differential Draft gauge by means of which

this pressure was read directly in inches of water.

In Print No 3 is shown a cross section of the apparatus used to guide and support the Pitot tube. F is a saddle flange , one of which was soldered to each pipe and was nearly the same size as shown in the figure. The knuckle joint E contained the guide tube " which was not removed while the Pitot was being moved from one pipe to another. The thumb screw D was used to clamp the guide tube to the knuckle joint , thus preventing the nose of the Pitot tube from being thrown out of line. The guide collar C guided the Pitot tube across the true diameter of the pipe and was soldered to the inside of the end of the guide tube. The set collar A was fitted loosely to the inside of the guide tube and could be clamped to the Pitot tube in any desired position by means of a small set screw. The guide tube H consisted of a brass tube five-sixteenths of an inch in internal diameter and eighteen inches long with a milled slot in one side. This tube supported

the weight of the rubber tubing and insured against the damaging of the frail Pitot tube. The sides of the slot were graduated in one eighth of an inch divisions and by means of a mark on the index collar , the height of the Pitot from the bottom of the pipe could be ascertained.

The Pitot tube was made of nickel tubing one sixteenth of an inch in diameter and about eighteen inches in length. The nose or portion whose axis was parallel to the center line of the pipe , when placed in position , was two and one half inches long and was neatly soldered at right angle to the end of the longer portion of the tube. To the upper end of the Pitot tube was soldered a small nozzle , similar to that of the pressure tube , onto which was slipped the rubber tubing leading to another differential draft gauge. This nozzle was of such diameter that when fitted with the rubber tubing there was enough friction between the rubber end and the

guide tube to support the Pitot tube in any desired position.

As each pipe was tested it was first fitted into an orifice plate and this plate was fastened by means of studs to the blower duct so that the axis of the pipe coincided with the axis of the duct. After inserting the Pitot tube as shown in Print 3 , the screw D and the screw fastening the index collar A to the tube were unloosened allowing the tube to be lowered until its nose rested on the bottom of the pipe. The nose was then adjusted parallel to the axis of the pipe and the screw D was tightened. The index collar A was then adjusted until the mark on it coincided with a convenient one on the guide tube and it was then securely fastened to the Pitot tube by means of the set screw.

The reading of the static head was taken once for each speed , while the dynamic head was taken for every eighth point within one and one half inches of the sides of the

pipe and at every quarter in between while the Pitot was traversing the diameter of the pipe.

In order to calculate the velocity of the air it is necessary to convert the gauge readings which are in inches of water to feet of air. Now if the air is only partially saturated the ratio of the weight of water present to that required for complete saturation at that given temperature and pressure is called the relative humidity. The latter also represents the ratio of the existing vapor tension to the maximum tension at that temperature. The degree of saturation or relative humidity is determined from the difference in reading of a wet and dry bulb thermometer , thus : If the air is completely saturated no evaporation takes place from the wet bulb and the two thermometers give identical readings ; but if it is unsaturated , evaporation takes place , the wet bulb thermometer is cooled and its reading is lower than that of the dry bulb. The difference in reading is a function of the relative humidity

and the latter is calculated by means of the following form or modification of Apjohn's formula :

$$h = \left(F_w - \frac{d P}{2640} \right) \frac{100}{F_d}$$

in which

h = relative humidity , per cent

d = difference in reading of the wet and dry thermometers , degrees Fahrenheit

F = barometric pressure , inches of mercury

F_w = maximum tension of aqueous vapor corresponding to the temperature of the wet thermometer , inches of mercury

F_d = maximum tension of aqueous vapor corresponding to the temperature of the dry thermometer , inches of mercury

Having found the relative humidity or the per cent of saturation , the pressure inside the tube is found. The pressure inside the tube is equal to the barometric pressure minus the static pressure divided by 13.6. From the tables we find the pounds of water vapor per pound of air at the temperature of the dry bulb

and then we reduce this to the per cent of saturation.

From Boyle's Law :-

$$p'v' \div T_1 = p_2 v_2 \div T_2$$

in which

p' = standard barometric pressure

p_2 = pressure inside the tube

v' = volume of gas at temperature T_1

v_2 = volume of gas at temperature T_2

T_1 = standard absolute temperature

T_2 = absolute temperature of the air

$$v_2 = p'v' T_2 \div p_2 T_1$$

Having determined v_2 we multiply it by the weight of one cubic foot of water at that temperature and divide by twelve. To this result we multiply the pounds of water vapor per pound of air at the given temperature and humidity added to one. This final result is equivalent to an inch of water and is used to reduce inches of water to feet of air. The velocity is found from the equation $V = \sqrt{2gh}$.

As an illustration let us take Run

No 1 made on April , 10 , 1911.

Barometer = 29.41

et Bulb Thermometer = 70

Dry Bulb Thermometer = 86

Difference in Temperature = 16

Static Head = .01

Pressure inside the Tube

$$29.41 - \frac{.01}{13.6} = 29.40$$

P = 29.40

$P_w = .739$

$P_d = 1.25$

d = 16

$$h = (.739 - \frac{16 \times 29.40}{2640}) \frac{100}{1.25} = 44.88\%$$

Pounds of water vapor per pound of air at 86 degrees Fahr. , and 44.88% saturated = .0122

Conversion of inches of water to feet of air

$p' = 29.92$

$p_2 = 29.40$

$v' = 11.58$

$T_1 = 460$

$$T_2 = 546$$

$$V_2 = 20.92 \times 11.58 \times 546 \div 29.409 \times 400 \\ = 13.96$$

Inches of water to feet of air :-

$$\frac{02.17 \times 13.96}{12} \times 1.0122 = 73.2$$

Equivalent of one inch of water = 73.2

In this manner the results were obtained as shown on the data sheets. Curves 1 to 11 inclusive show the relation between the actual velocity and the diameter of the tubes in inches. Curves 12 to 55 inclusive are curves plotted according to Mr Burnham's method of finding the mean velocity radius.

PLATE I

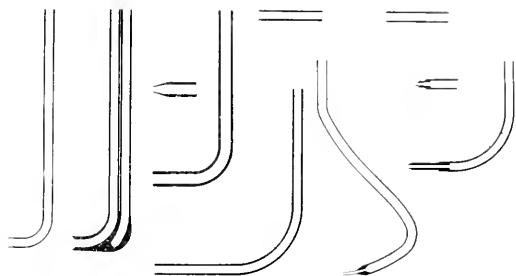


PLATE II

EXPERIMENTAL MODEL BASIN
PITOT TUBE
FOR
DETERMINING AIR VELOCITIES.

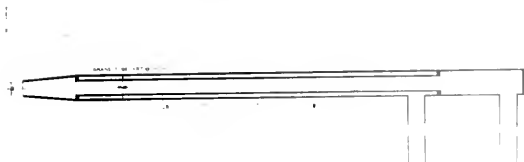


PLATE III

A METHOD
OF
INSTRUMENTS OF PERSPECTIVE

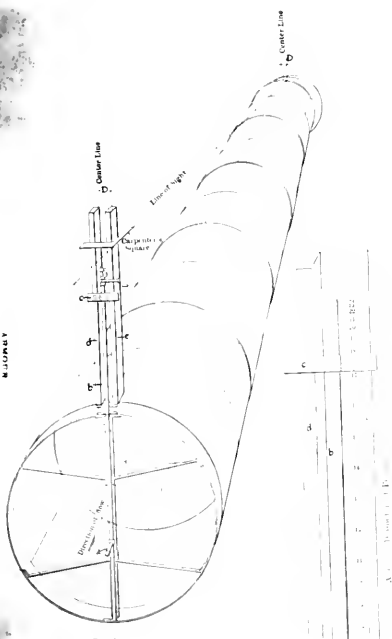


PLATE IV

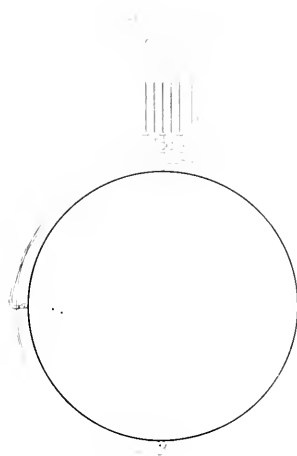


PLATE V

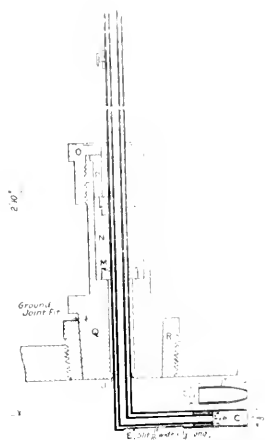


FIG. 1. Section Through Pitot Tube and Stuffing Box, Used on Gas Main.

PLATE VI



PLATE VII



PLATE VIII

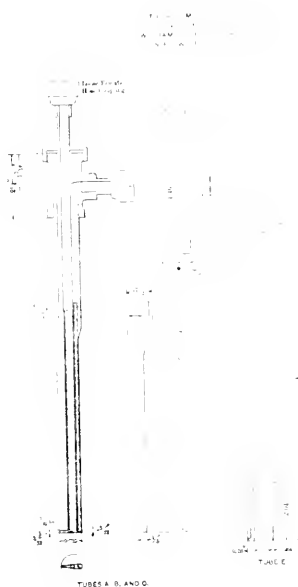


PLATE IX

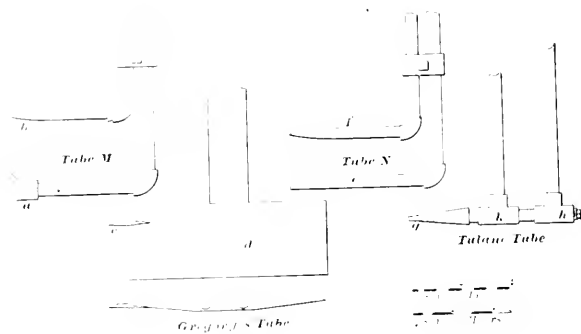


Fig. 24

PLATE X

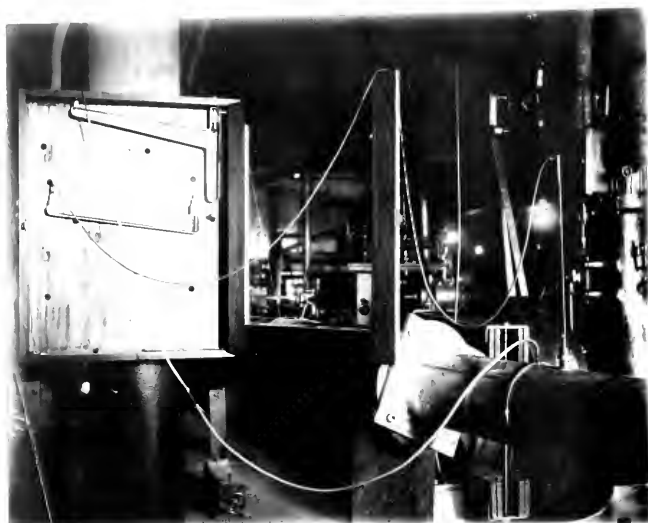
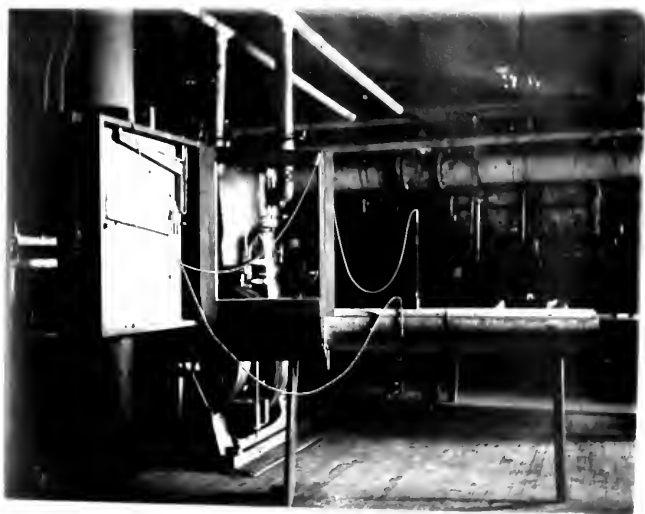
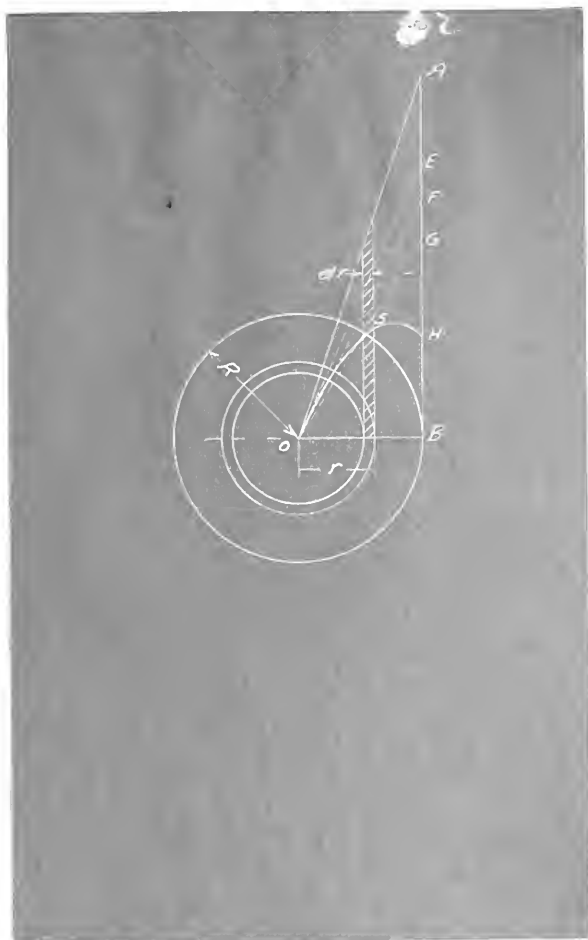


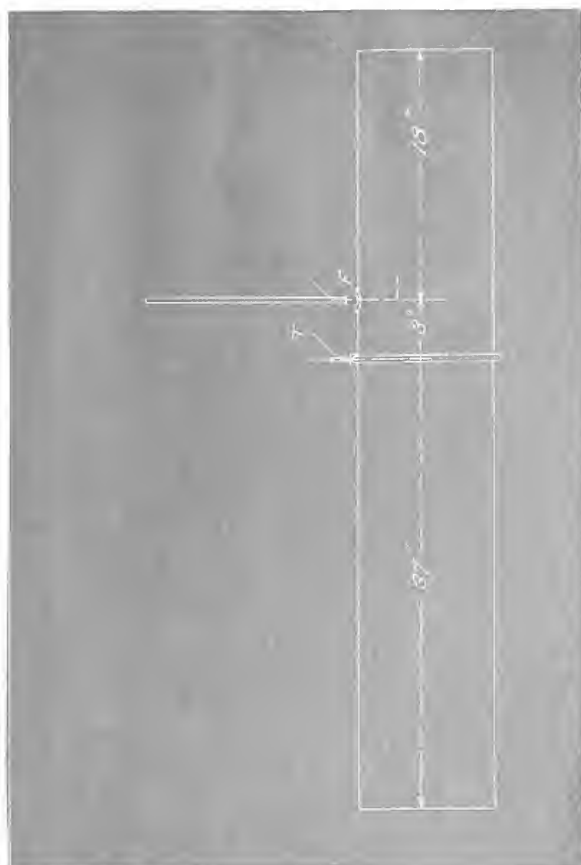
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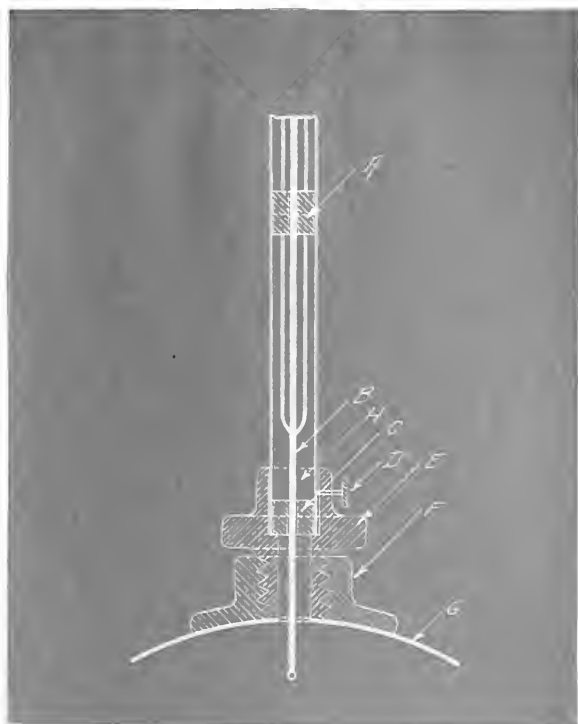
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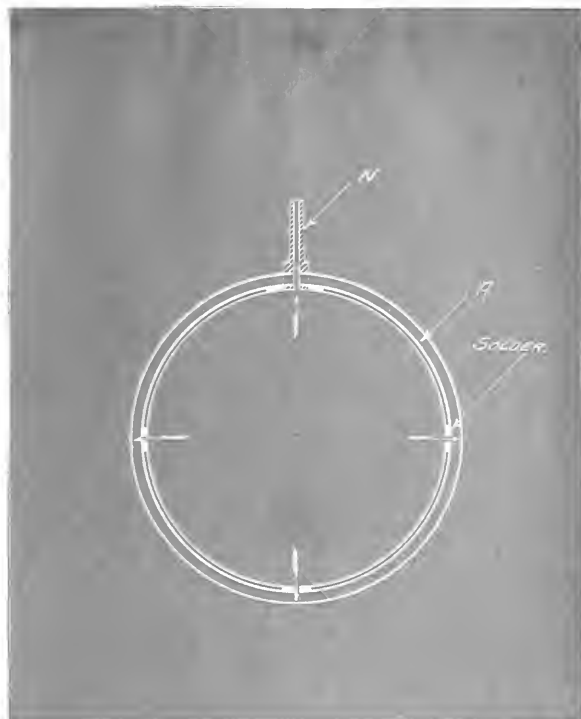
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PRINT NO 3

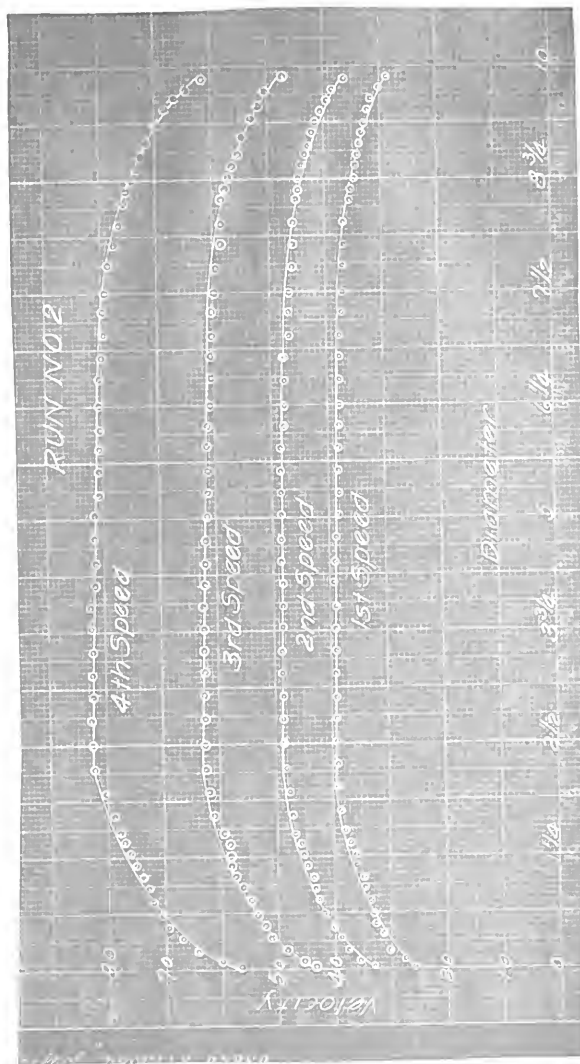


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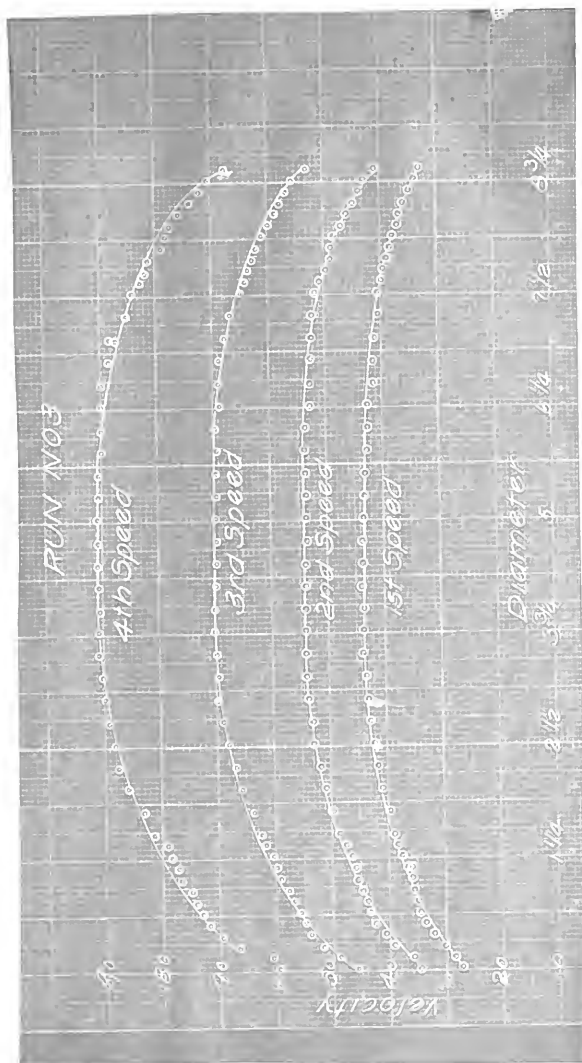


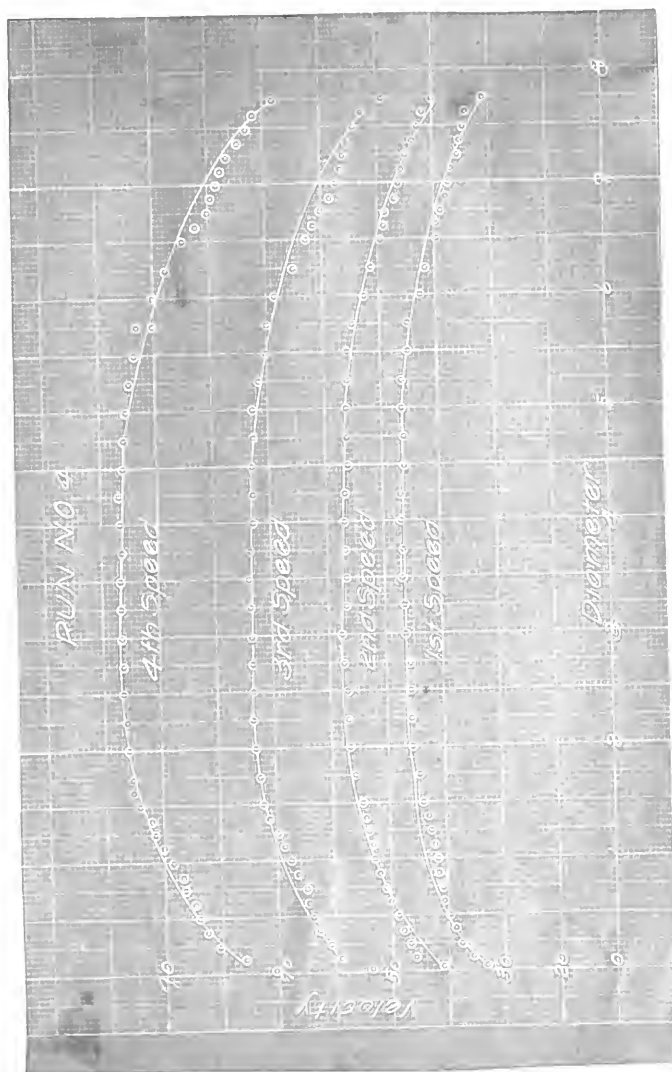
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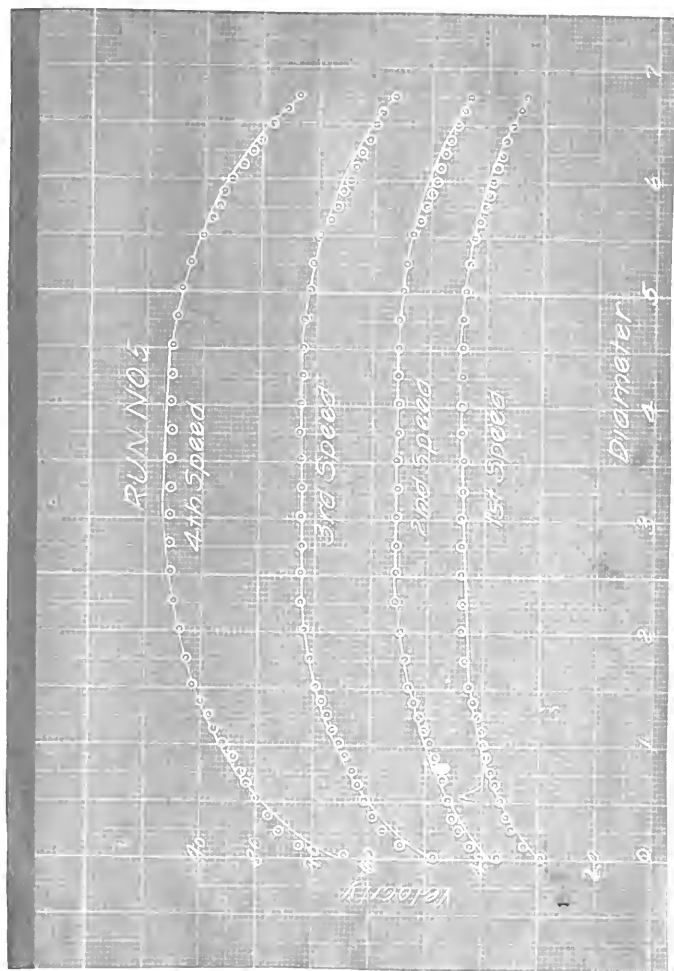


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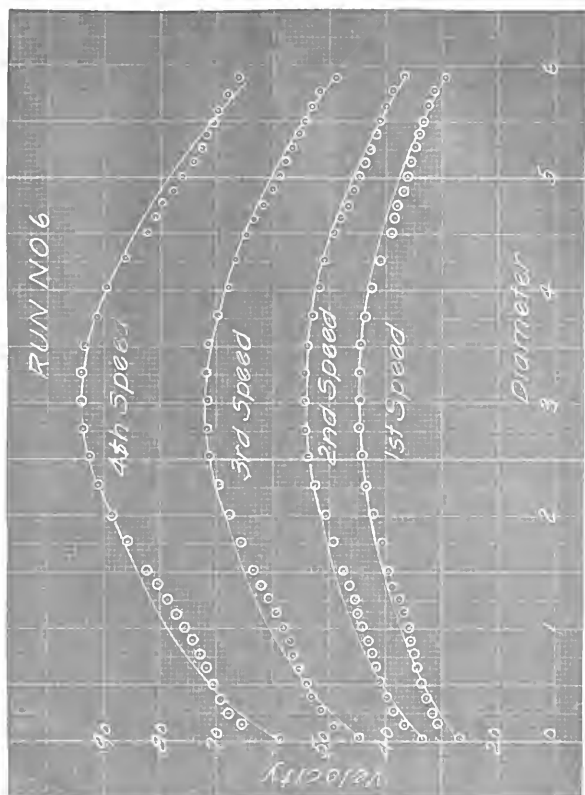




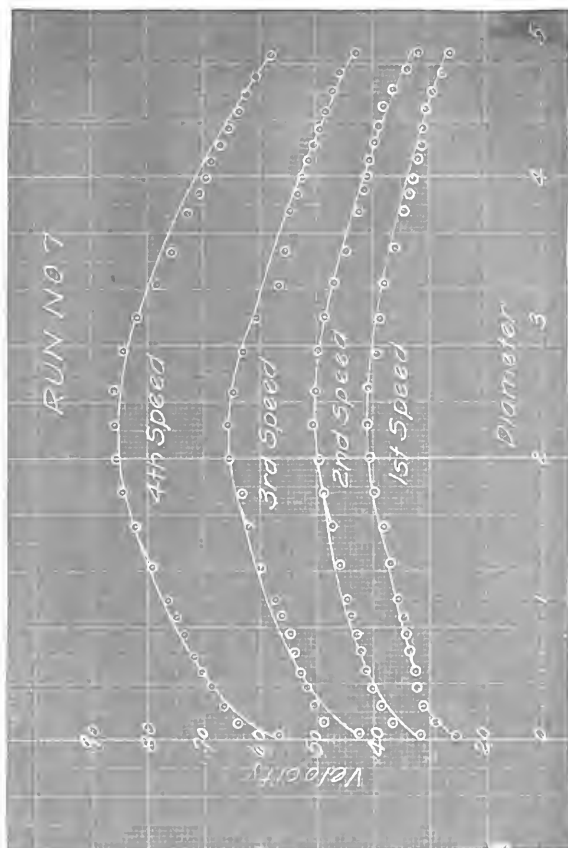
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CURVE NO 6



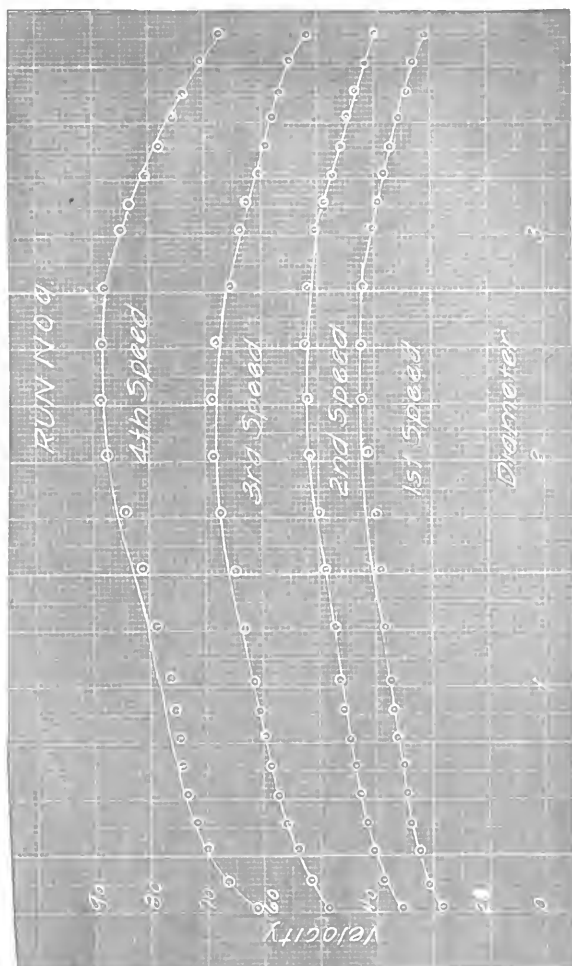
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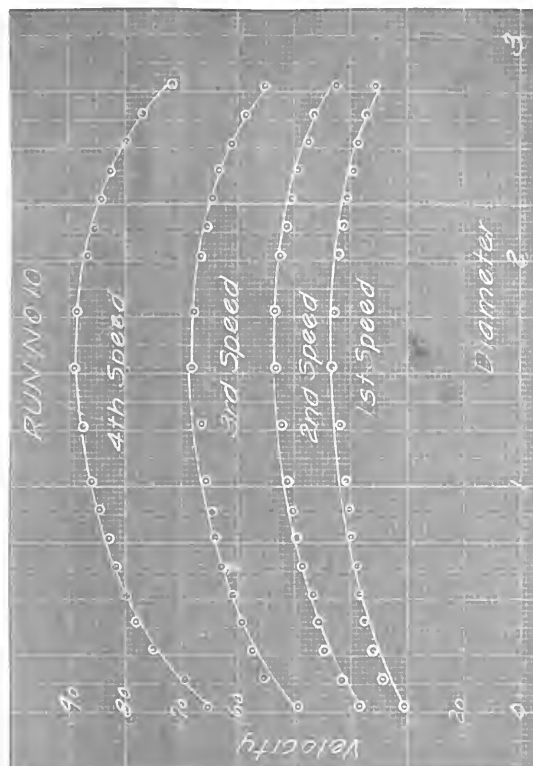
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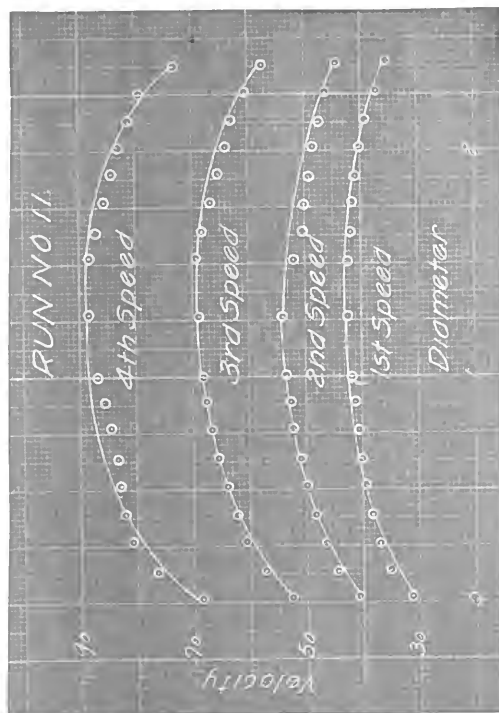
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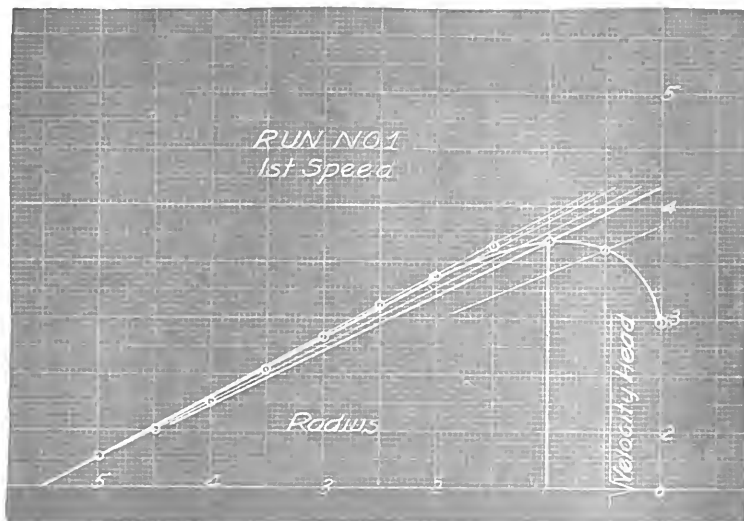
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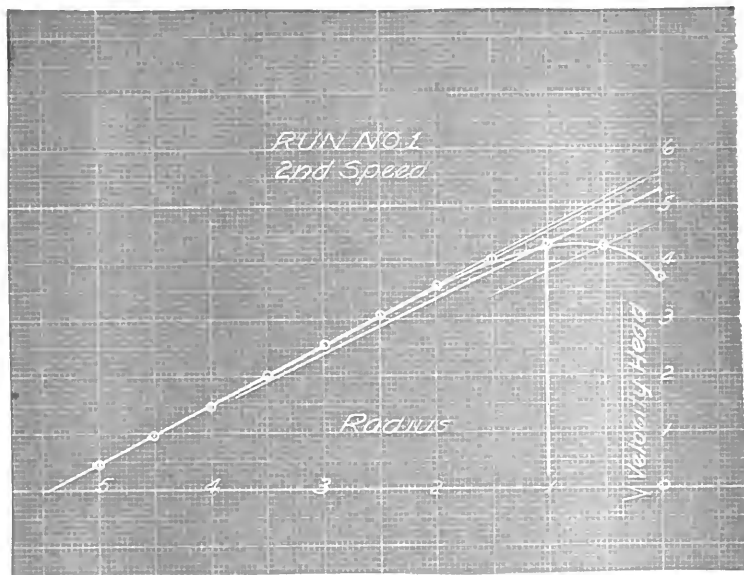
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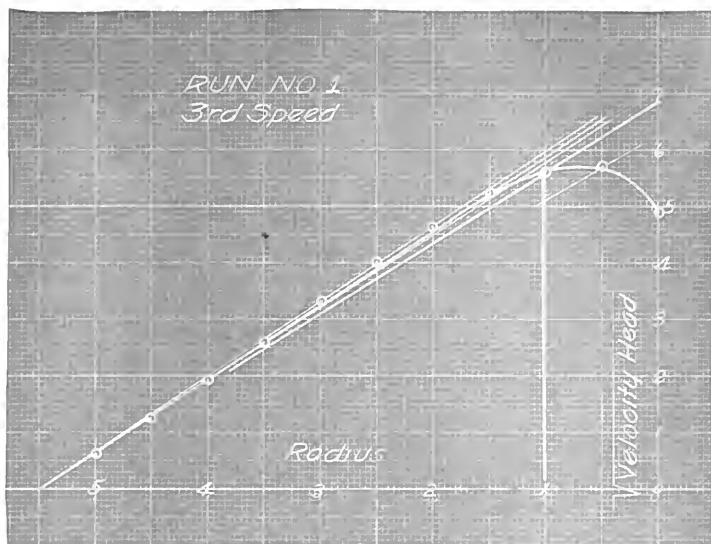
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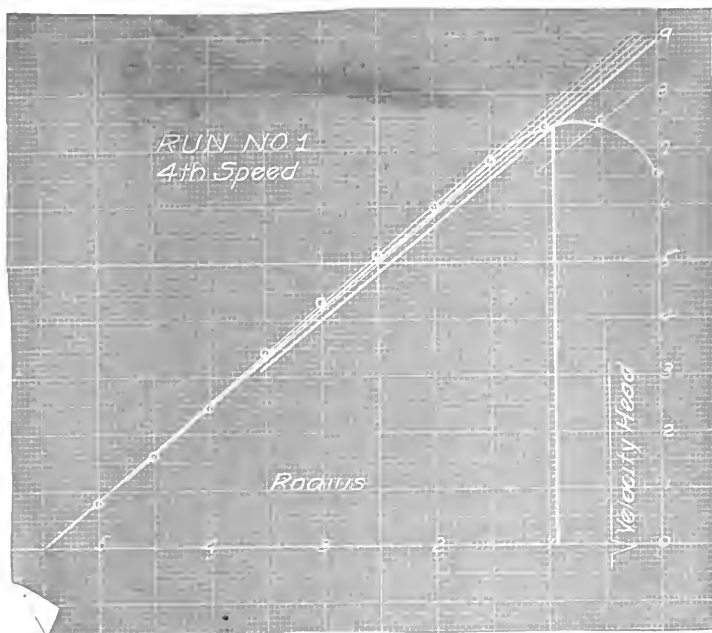
CURVE NO 13



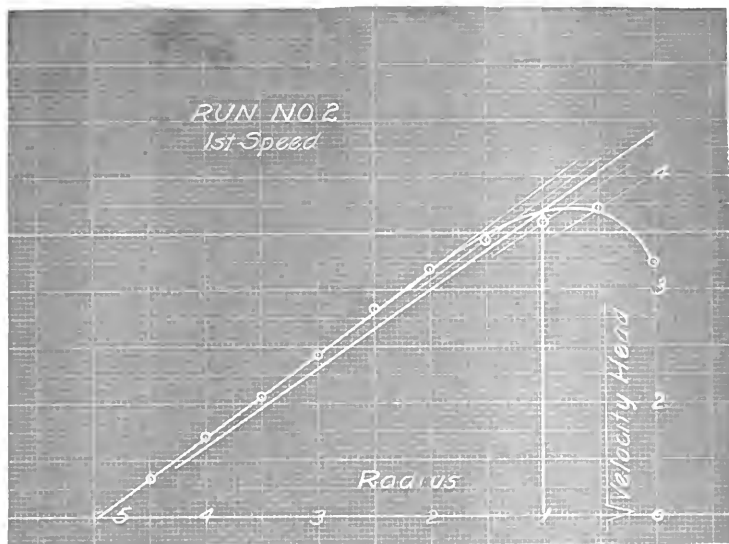
CURVE NO 14



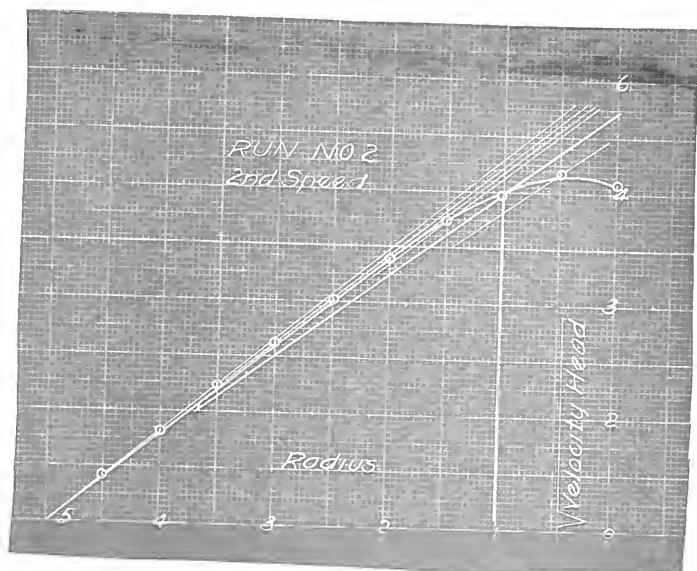
CURVE NO 15



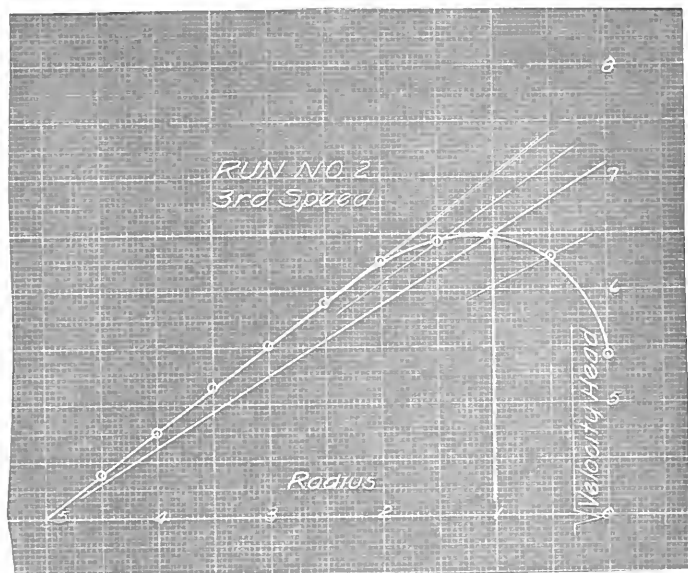
CURVE NO 16



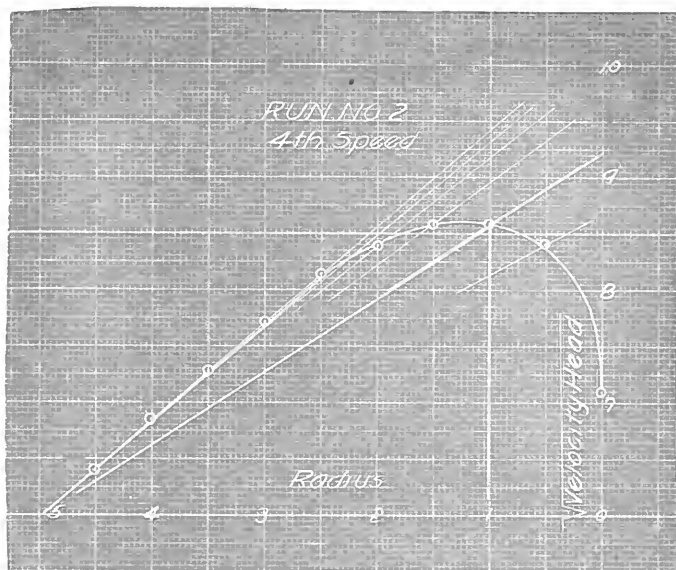
CURVE NO 17



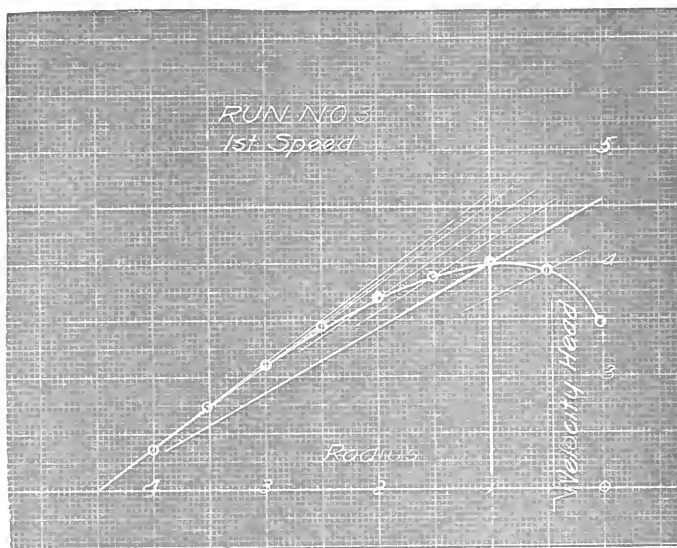
CURVE NO 18



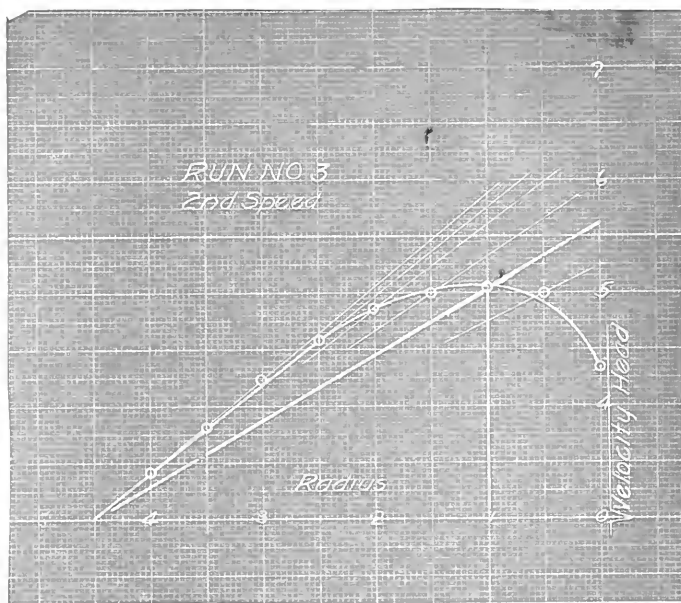
CURVE NO 19



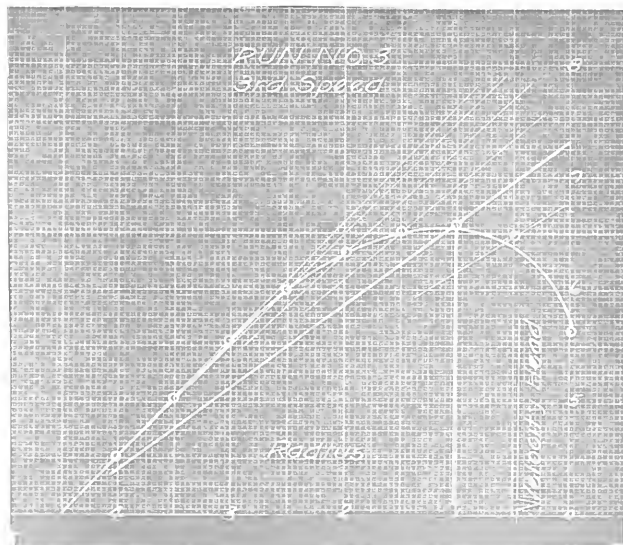
CURVE NO 20



CURVE NO 21



CURVE NO 22



CURVE NO 23

RUN NO 3

High Speed

Radius

Velocity, Hsdd

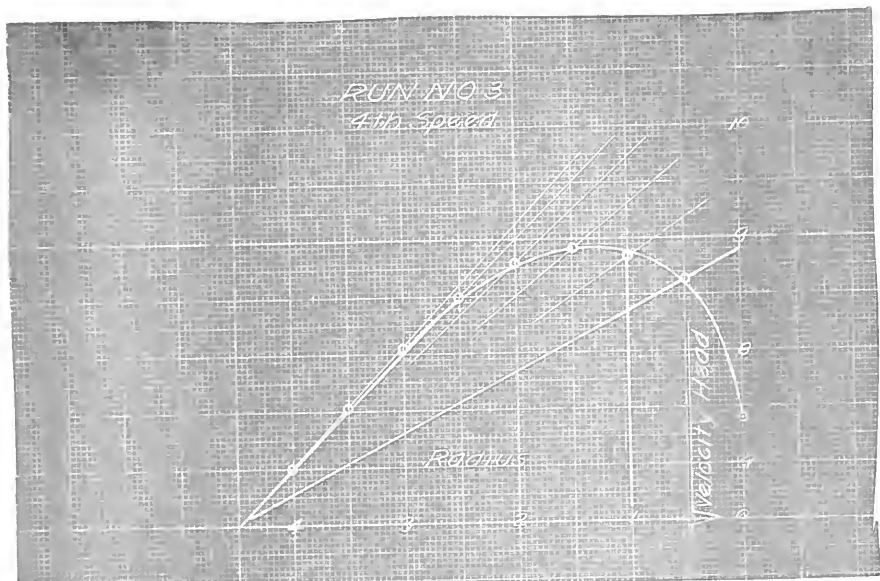
10

8

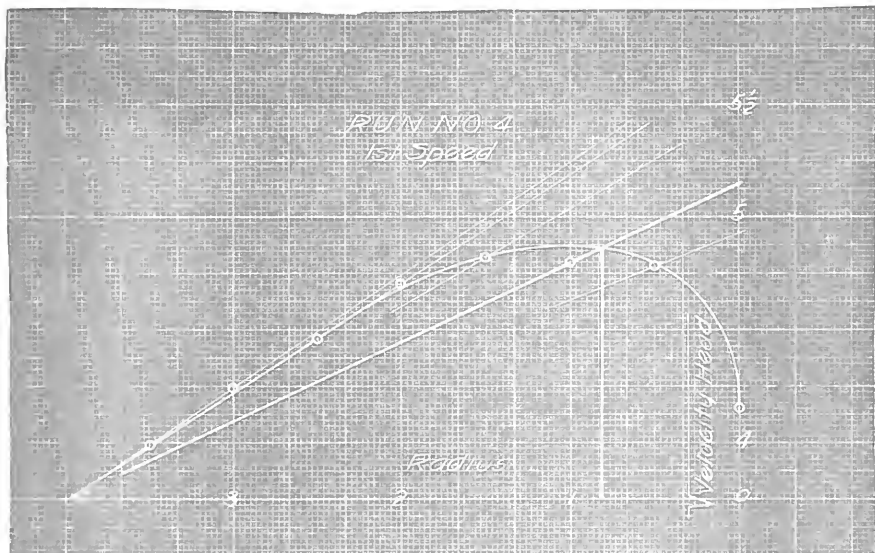
6

4

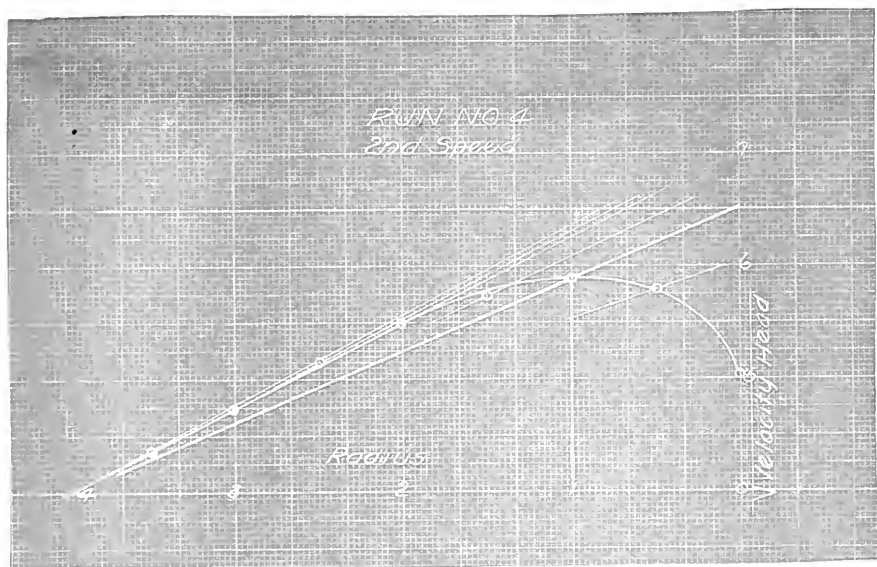
2



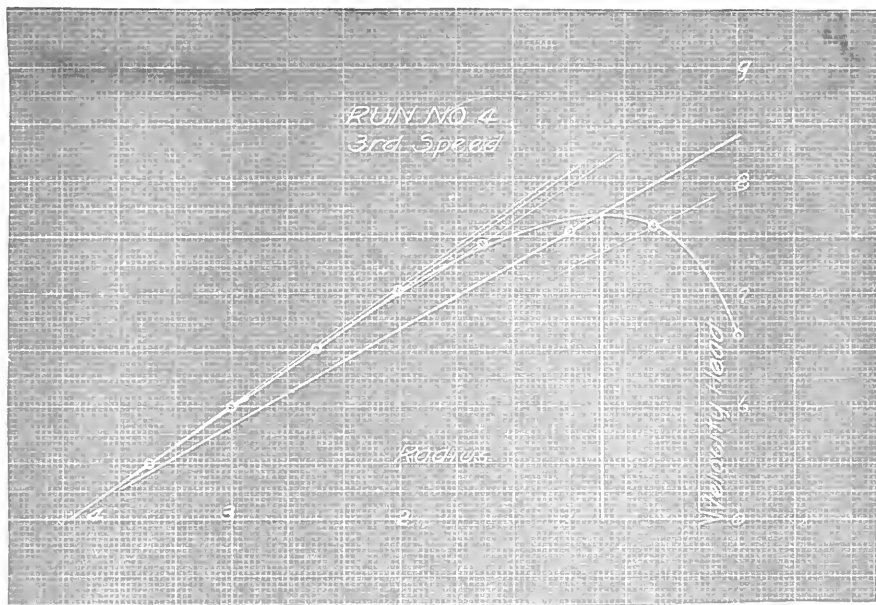
CURVE NO 24



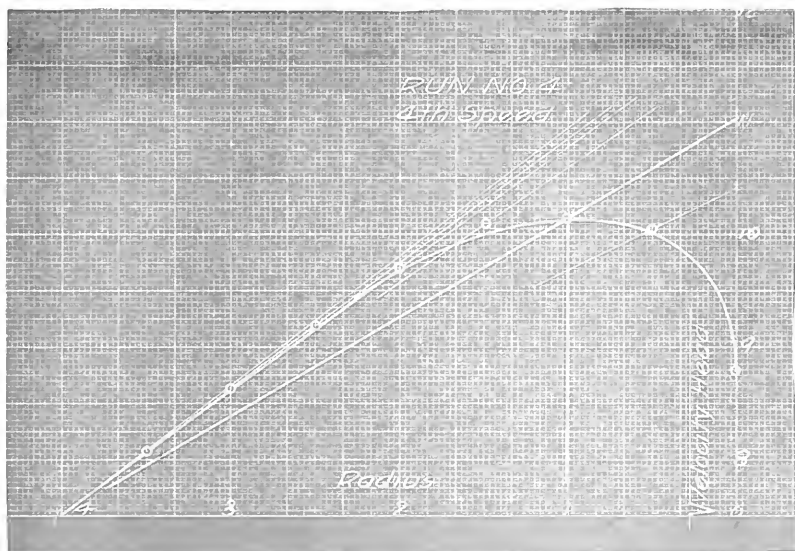
CURVE NO 25



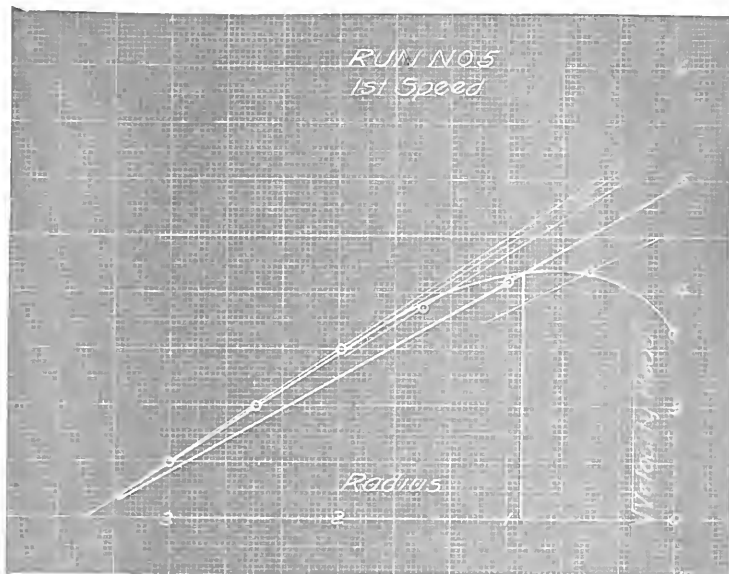
CURVE NO. 6



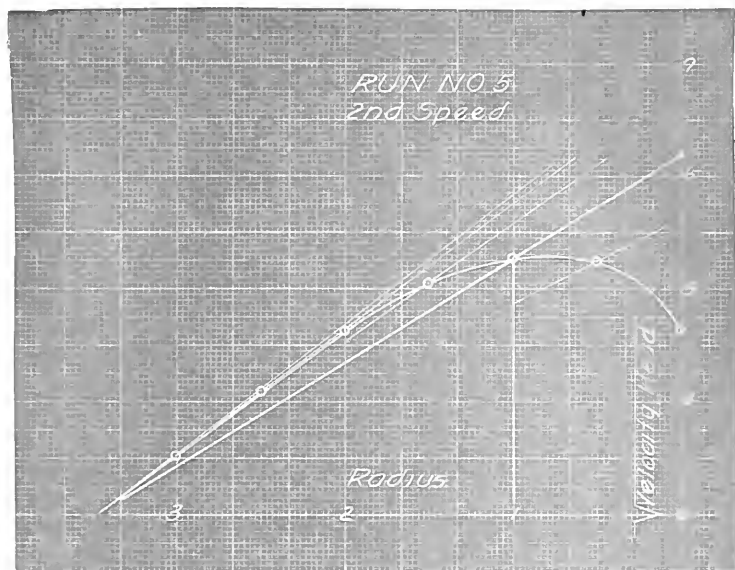
CURVE NO 27



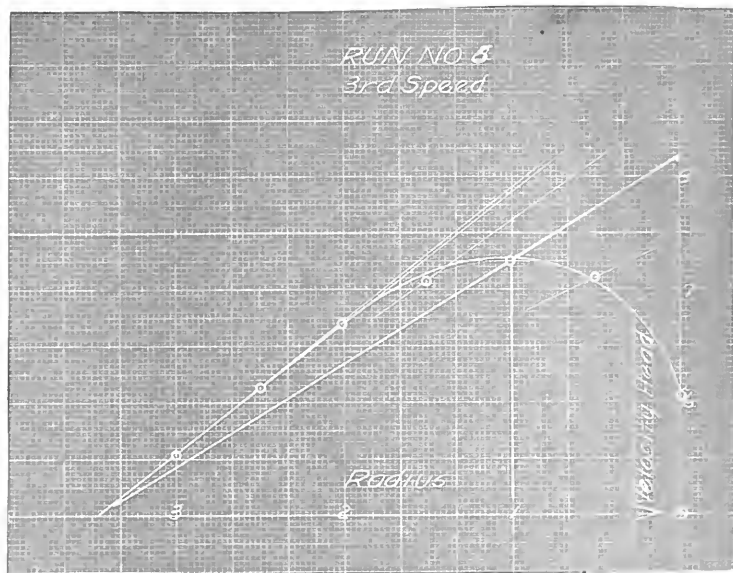
CURVE NO 28



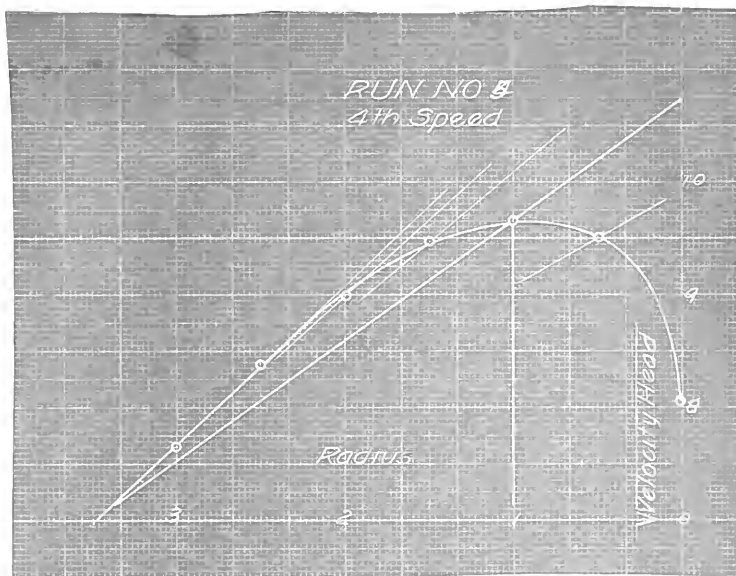
CURVE NO 29



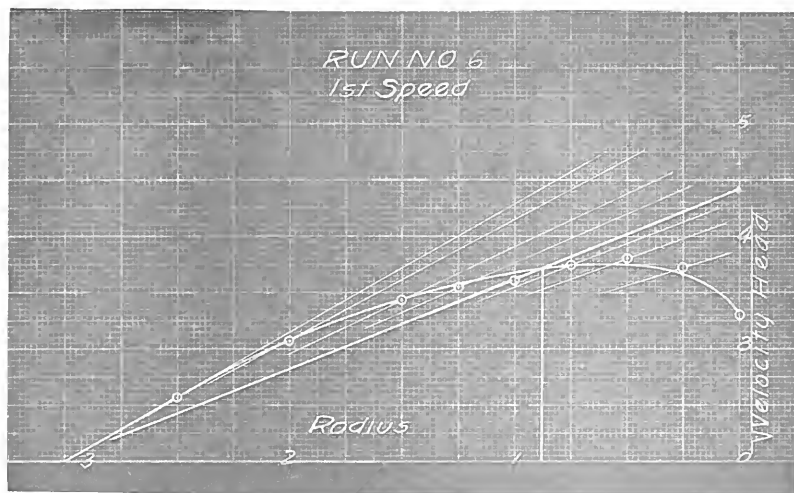
CURVE NO 30



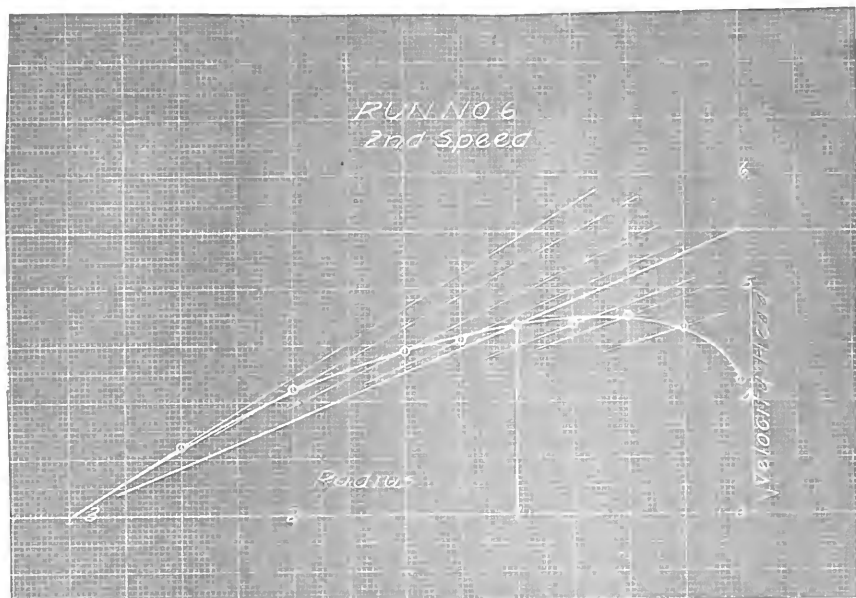
CURVE NO 31



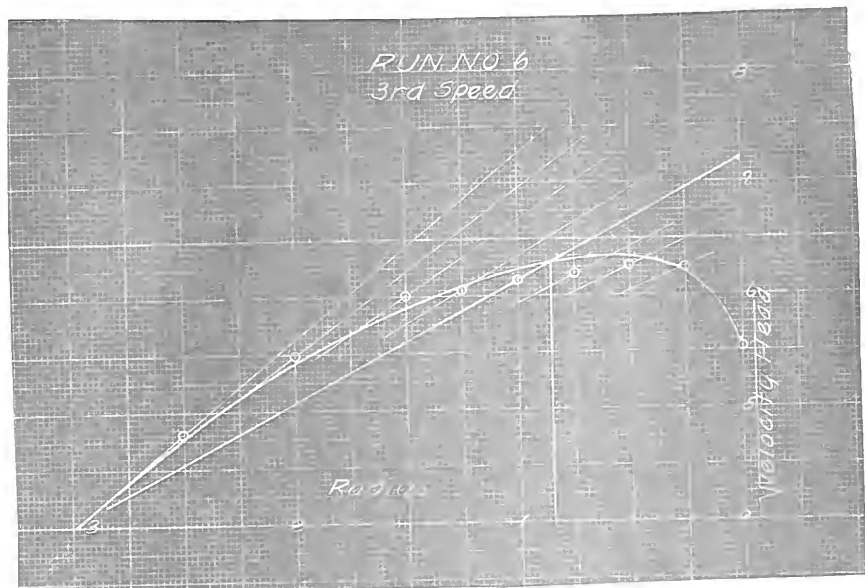
CURVE NO 32



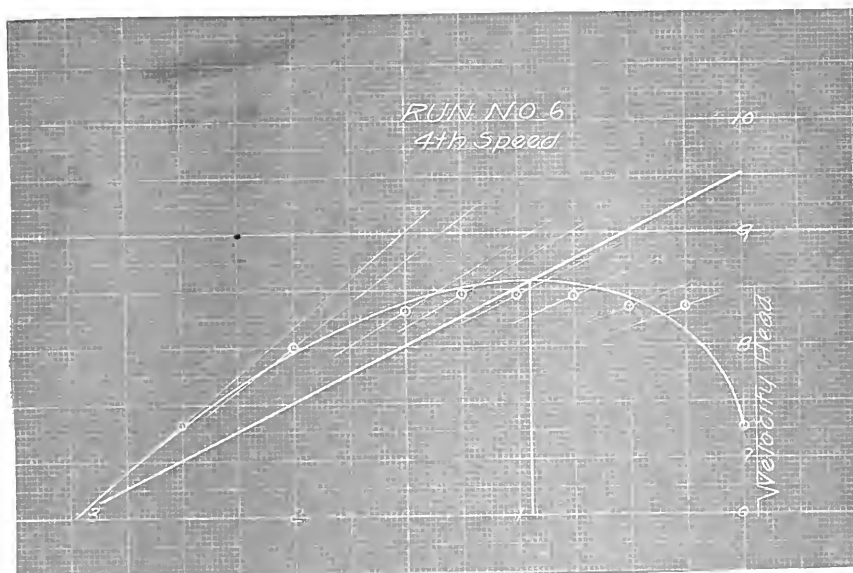
CURVE NO 33



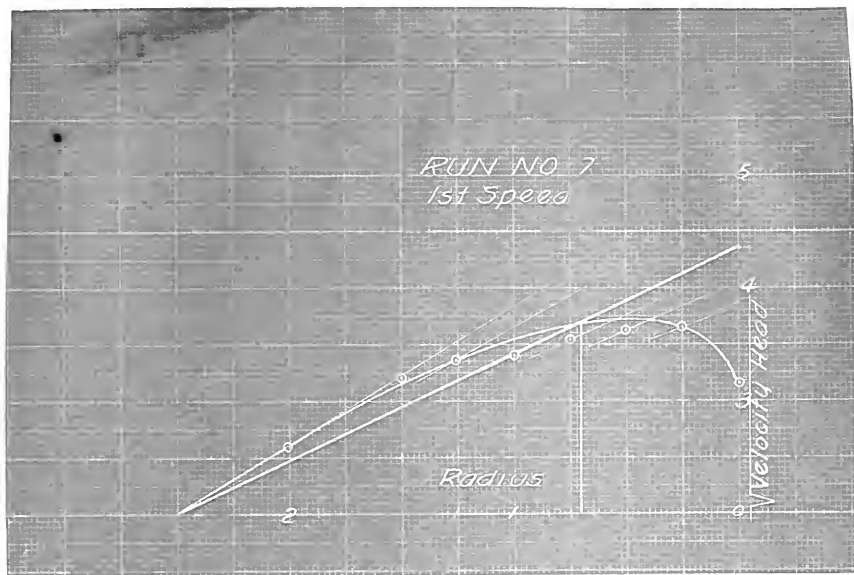
CURVE NO 34

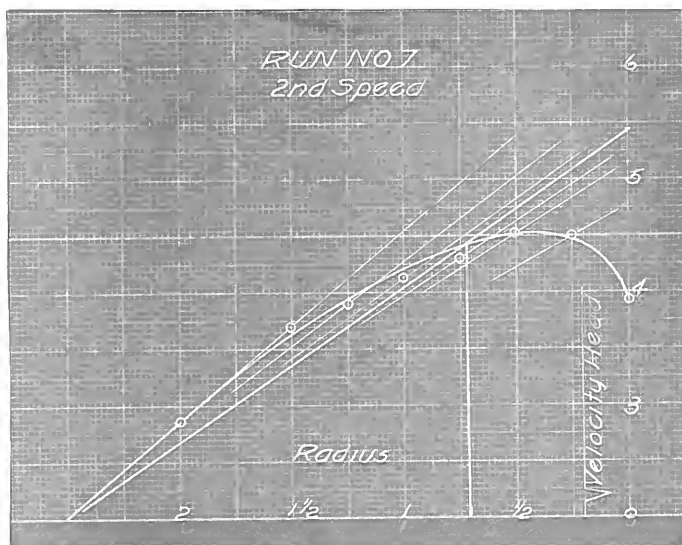


CURVE NO 35



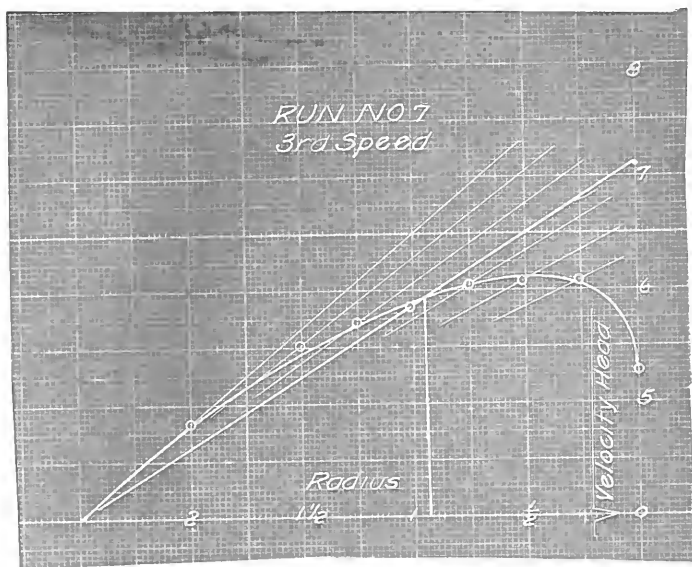
CURV NO 36



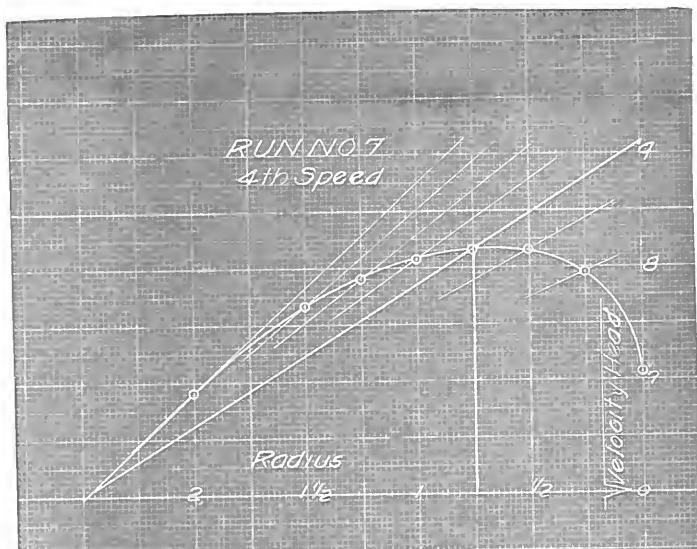


CURVE NO 37

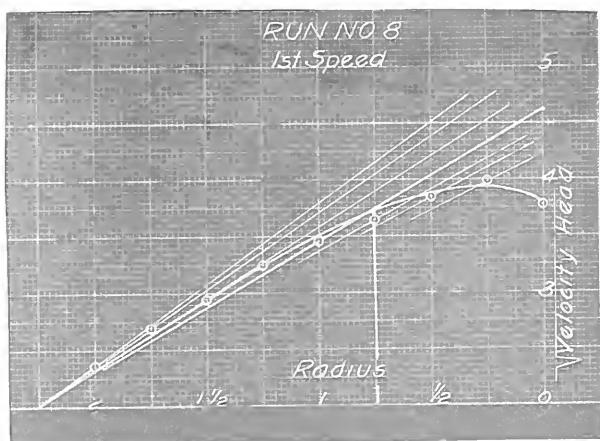
CURVE NO 38



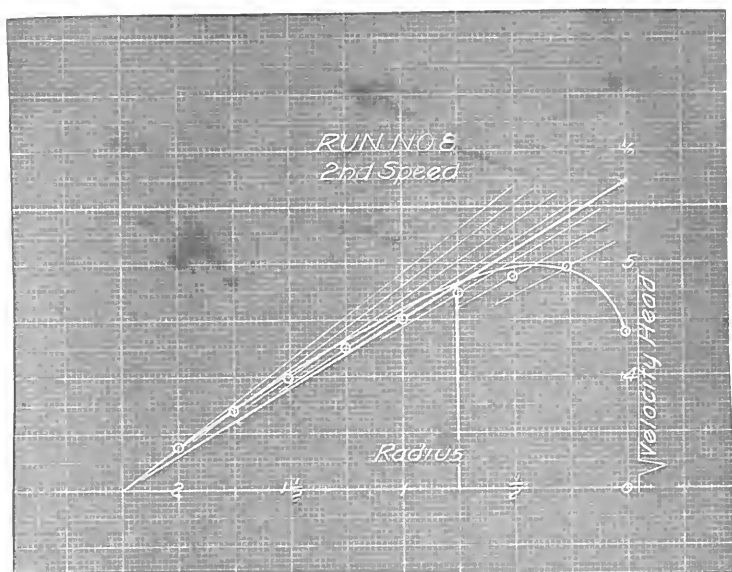
CURVE NO 39



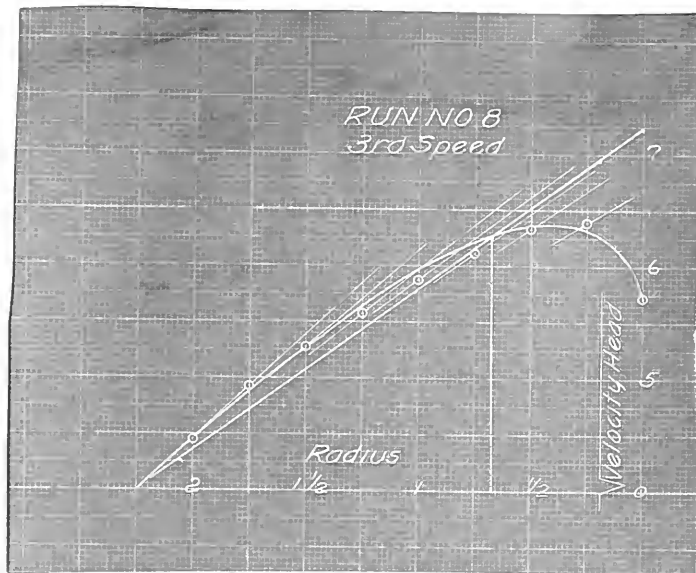
CURVE NO 40



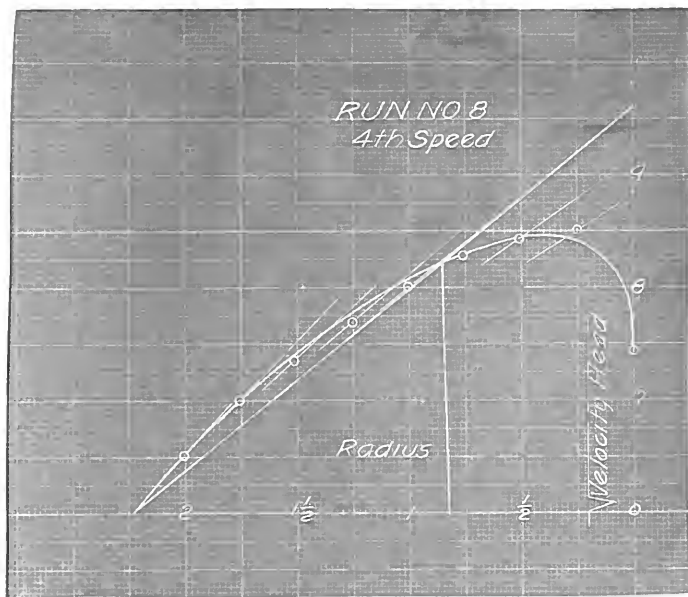
CURVE NO 41



CURVE NO 42

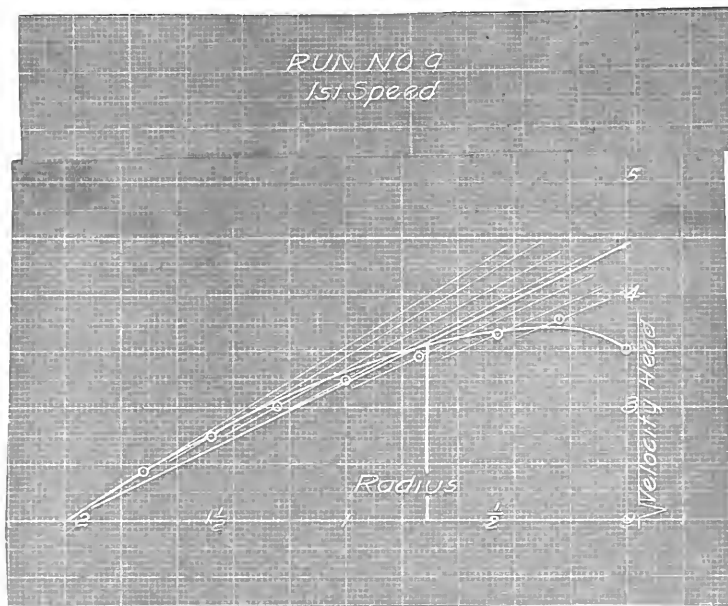


CURVE NO 43

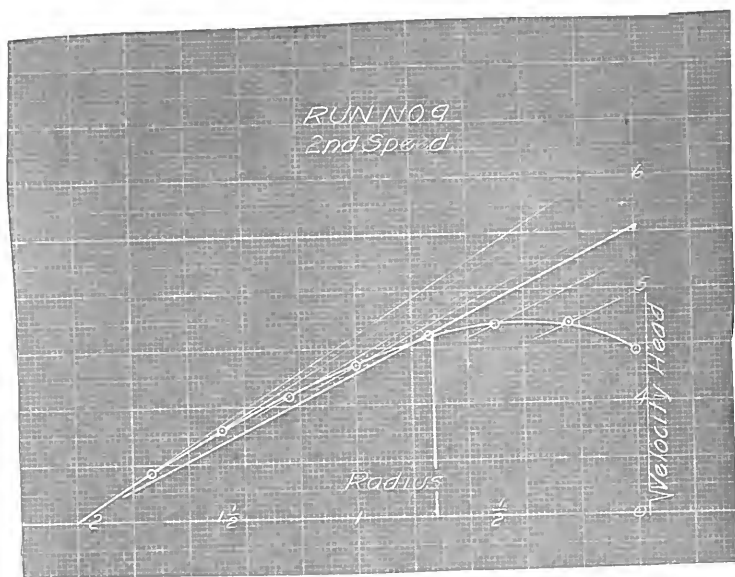




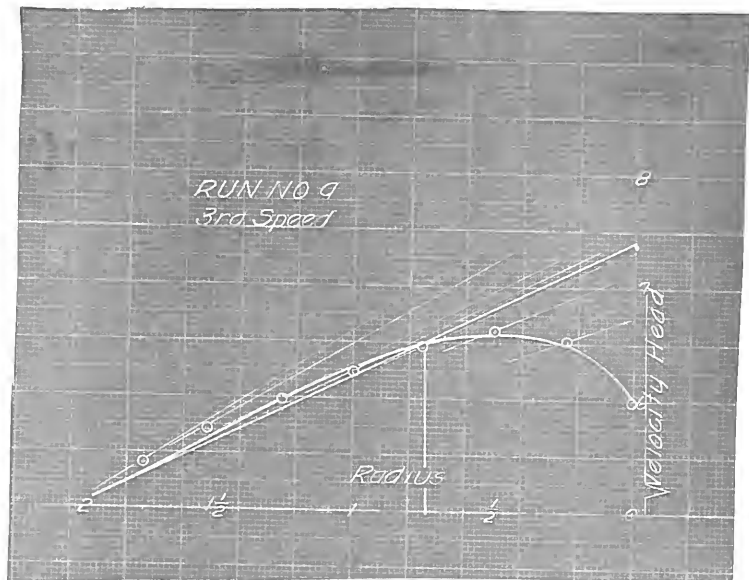
CURVE NO 44



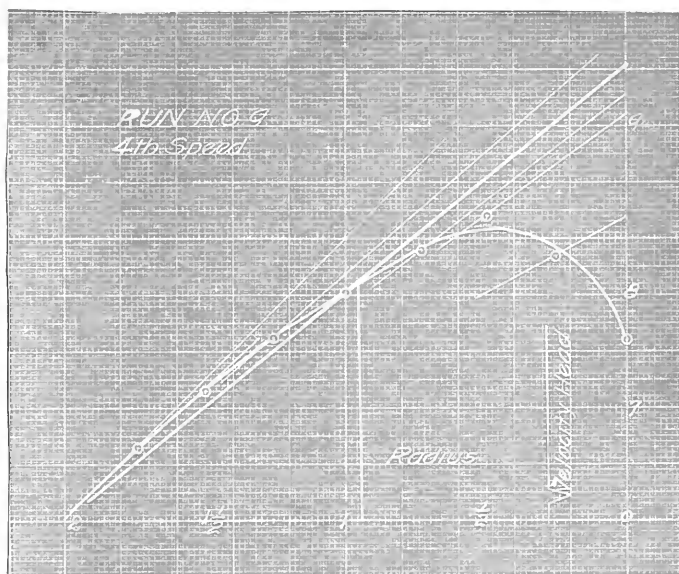
CURVE NO 45



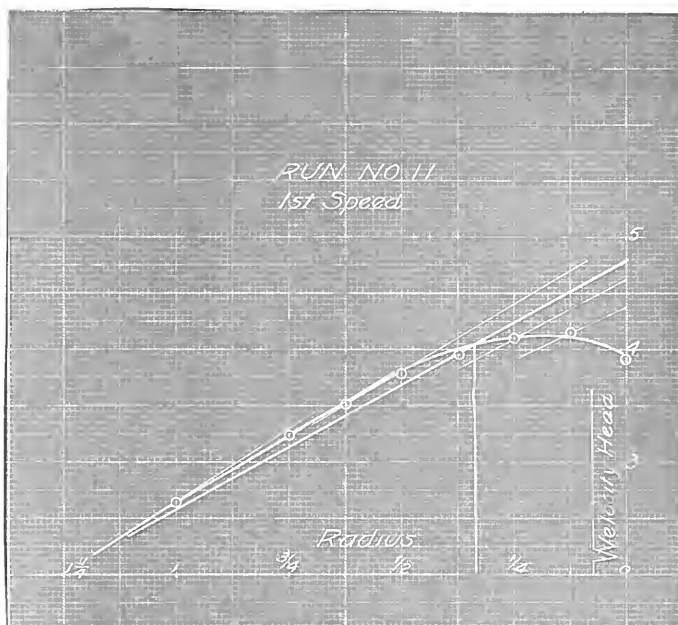
CURVE NO 46



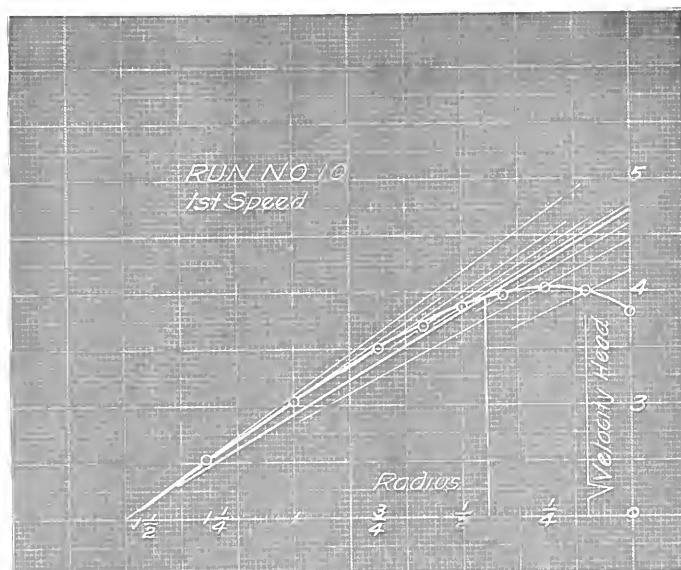
CURVE NO 47



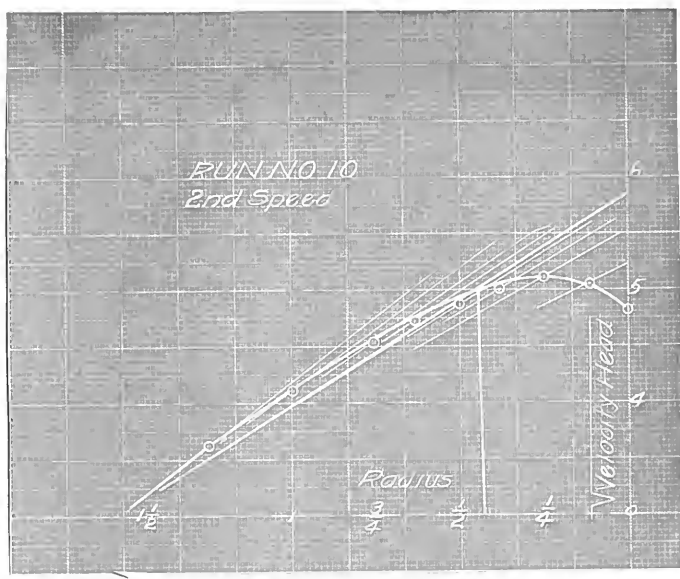
CURVE NO 48



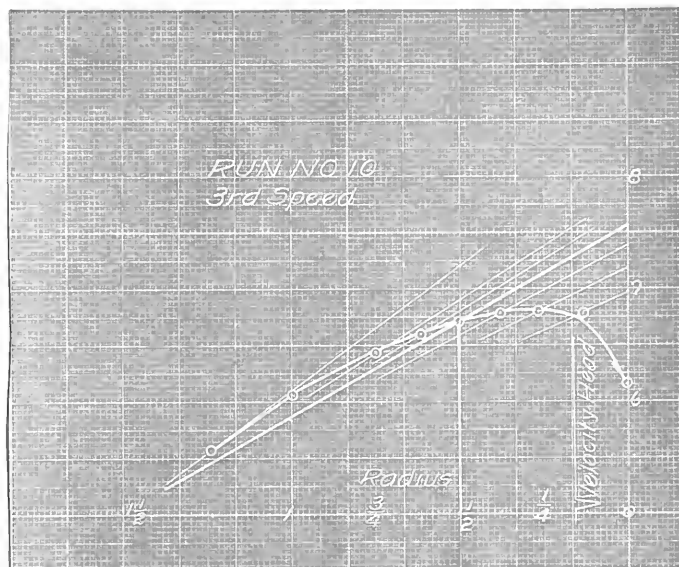
CURVE NO 49



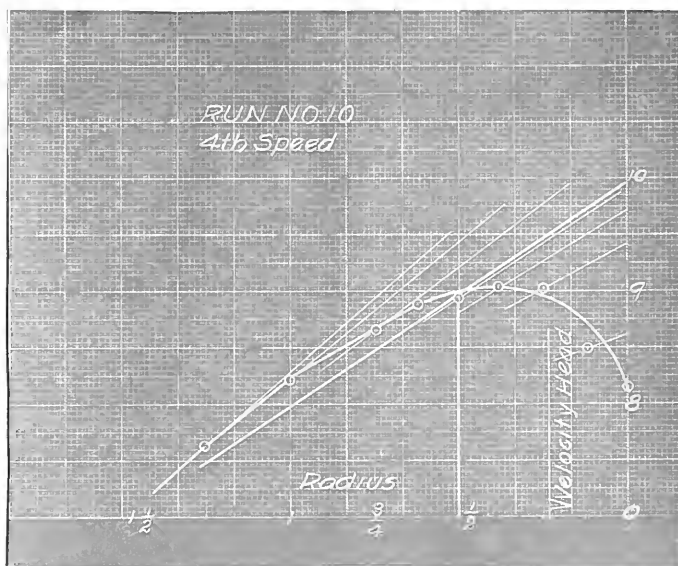
CURVE NO 50



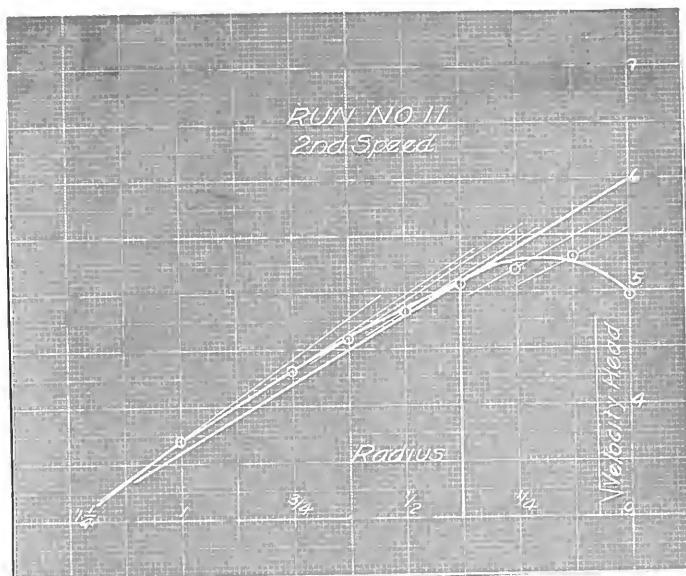
CURVE NO 57



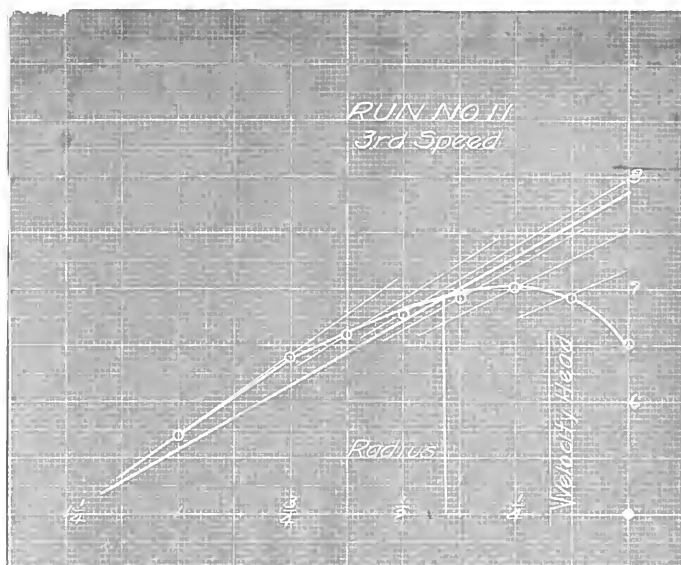
CURVE NO 52



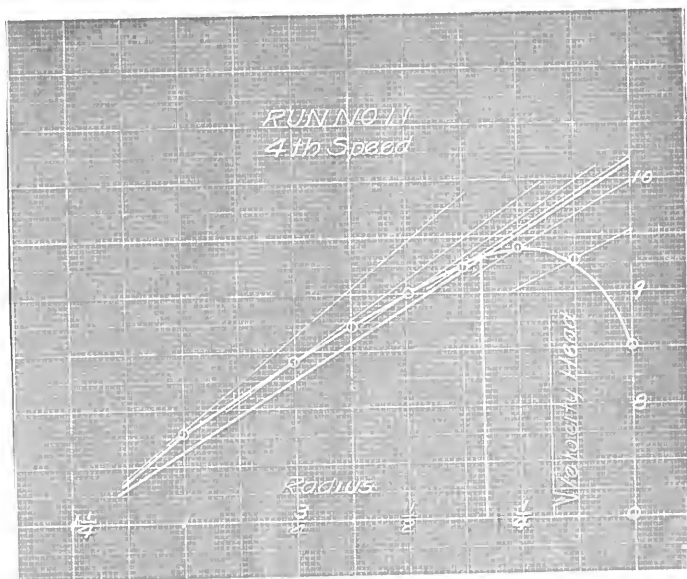
CURVE NO 53



CURVE NO 54



CURVE NO 55



No.	No.	Distance	SPEED 1			SPEED No. 4.			
			Inches of H ₂ O.	Feet of air	M per sec.	Inches of H ₂ O.	Feet of air.	\sqrt{H} .	Mean velocity.
1	1	$\frac{1}{32}$	.15	10.52		.71	49.90	7.06	56.70
2	2	$\frac{2}{32}$	.17	11.93		.80	56.20	7.97	60.10
3	3	$\frac{3}{32}$	.21	14.75		.92	64.60	8.08	67.50
4	4	$\frac{4}{32}$	.22	15.45		1.07	71.00	8.42	67.60
5	5	$\frac{5}{32}$	.23	16.15		1.07	75.20	8.67	69.60
6	6	$\frac{6}{32}$	.24	16.85		1.09	76.60	8.75	70.25
7	7	$\frac{7}{32}$	.25	17.55		1.15	80.80	8.98	72.05

... in pipe

SPEED No 1				SPEED No 2				SPEED No 3				SPEED No 4			
Time	Temp	Wind	Pressure	Time	Temp	Wind	Pressure	Time	Temp	Wind	Pressure	Time	Temp	Wind	Pressure
10:00	65.0	10.0	30.0	10:05	65.5	10.5	30.0	10:10	66.0	11.0	30.0	10:15	66.5	11.5	30.0
10:20	66.0	11.0	30.0	10:25	66.5	11.5	30.0	10:30	67.0	12.0	30.0	10:35	67.5	12.5	30.0
10:40	67.0	12.0	30.0	10:45	67.5	12.5	30.0	10:50	68.0	13.0	30.0	10:55	68.5	13.5	30.0
11:00	68.0	13.0	30.0	11:05	68.5	13.5	30.0	11:10	69.0	14.0	30.0	11:15	69.5	14.5	30.0
11:20	69.0	14.0	30.0	11:25	69.5	14.5	30.0	11:30	70.0	15.0	30.0	11:35	70.5	15.5	30.0
11:40	70.0	15.0	30.0	11:45	70.5	15.5	30.0	11:50	71.0	16.0	30.0	11:55	71.5	16.5	30.0
12:00	71.0	16.0	30.0	12:05	71.5	16.5	30.0	12:10	72.0	17.0	30.0	12:15	72.5	17.5	30.0
12:20	72.0	17.0	30.0	12:25	72.5	17.5	30.0	12:30	73.0	18.0	30.0	12:35	73.5	18.5	30.0
12:40	73.0	18.0	30.0	12:45	73.5	18.5	30.0	12:50	74.0	19.0	30.0	12:55	74.5	19.5	30.0
13:00	74.0	19.0	30.0	13:05	74.5	19.5	30.0	13:10	75.0	20.0	30.0	13:15	75.5	20.5	30.0
13:20	75.0	20.0	30.0	13:25	75.5	20.5	30.0	13:30	76.0	21.0	30.0	13:35	76.5	21.5	30.0
13:40	76.0	21.0	30.0	13:45	76.5	21.5	30.0	13:50	77.0	22.0	30.0	13:55	77.5	22.5	30.0
14:00	77.0	22.0	30.0	14:05	77.5	22.5	30.0	14:10	78.0	23.0	30.0	14:15	78.5	23.5	30.0
14:20	78.0	23.0	30.0	14:25	78.5	23.5	30.0	14:30	79.0	24.0	30.0	14:35	79.5	24.5	30.0
14:40	79.0	24.0	30.0	14:45	79.5	24.5	30.0	14:50	80.0	25.0	30.0	14:55	80.5	25.5	30.0
15:00	80.0	25.0	30.0	15:05	80.5	25.5	30.0	15:10	81.0	26.0	30.0	15:15	81.5	26.5	30.0
15:20	81.0	26.0	30.0	15:25	81.5	26.5	30.0	15:30	82.0	27.0	30.0	15:35	82.5	27.5	30.0
15:40	82.0	27.0	30.0	15:45	82.5	27.5	30.0	15:50	83.0	28.0	30.0	15:55	83.5	28.5	30.0
16:00	83.0	28.0	30.0	16:05	83.5	28.5	30.0	16:10	84.0	29.0	30.0	16:15	84.5	29.5	30.0
16:20	84.0	29.0	30.0	16:25	84.5	29.5	30.0	16:30	85.0	30.0	30.0	16:35	85.5	30.5	30.0
16:40	85.0	30.0	30.0	16:45	85.5	30.5	30.0	16:50	86.0	31.0	30.0	16:55	86.5	31.5	30.0
17:00	86.0	31.0	30.0	17:05	86.5	31.5	30.0	17:10	87.0	32.0	30.0	17:15	87.5	32.5	30.0
17:20	87.0	32.0	30.0	17:25	87.5	32.5	30.0	17:30	88.0	33.0	30.0	17:35	88.5	33.5	30.0
17:40	88.0	33.0	30.0	17:45	88.5	33.5	30.0	17:50	89.0	34.0	30.0	17:55	89.5	34.5	30.0
18:00	89.0	34.0	30.0	18:05	89.5	34.5	30.0	18:10	90.0	35.0	30.0	18:15	90.5	35.5	30.0
18:20	90.0	35.0	30.0	18:25	90.5	35.5	30.0	18:30	91.0	36.0	30.0	18:35	91.5	36.5	30.0
18:40	91.0	36.0	30.0	18:45	91.5	36.5	30.0	18:50	92.0	37.0	30.0	18:55	92.5	37.5	30.0
19:00	92.0	37.0	30.0	19:05	92.5	37.5	30.0	19:10	93.0	38.0	30.0	19:15	93.5	38.5	30.0
19:20	93.0	38.0	30.0	19:25	93.5	38.5	30.0	19:30	94.0	39.0	30.0	19:35	94.5	39.5	30.0
19:40	94.0	39.0	30.0	19:45	94.5	39.5	30.0	19:50	95.0	40.0	30.0	19:55	95.5	40.5	30.0
20:00	95.0	40.0	30.0	20:05	95.5	40.5	30.0	20:10	96.0	41.0	30.0	20:15	96.5	41.5	30.0
20:20	96.0	41.0	30.0	20:25	96.5	41.5	30.0	20:30	97.0	42.0	30.0	20:35	97.5	42.5	30.0
20:40	97.0	42.0	30.0	20:45	97.5	42.5	30.0	20:50	98.0	43.0	30.0	20:55	98.5	43.5	30.0
21:00	98.0	43.0	30.0	21:05	98.5	43.5	30.0	21:10	99.0	44.0	30.0	21:15	99.5	44.5	30.0
21:20	99.0	44.0	30.0	21:25	99.5	44.5	30.0	21:30	100.0	45.0	30.0	21:35	100.5	45.5	30.0
21:40	100.0	45.0	30.0	21:45	100.5	45.5	30.0	21:50	101.0	46.0	30.0	21:55	101.5	46.5	30.0
22:00	101.0	46.0	30.0	22:05	101.5	46.5	30.0	22:10	102.0	47.0	30.0	22:15	102.5	47.5	30.0
22:20	102.0	47.0	30.0	22:25	102.5	47.5	30.0	22:30	103.0	48.0	30.0	22:35	103.5	48.5	30.0
22:40	103.0	48.0	30.0	22:45	103.5	48.5	30.0	22:50	104.0	49.0	30.0	22:55	104.5	49.5	30.0
23:00	104.0	49.0	30.0	23:05	104.5	49.5	30.0	23:10	105.0	50.0	30.0	23:15	105.5	50.5	30.0
23:20	105.0	50.0	30.0	23:25	105.5	50.5	30.0	23:30	106.0	51.0	30.0	23:35	106.5	51.5	30.0
23:40	106.0	51.0	30.0	23:45	106.5	51.5	30.0	23:50	107.0	52.0	30.0	23:55	107.5	52.5	30.0
24:00	107.0	52.0	30.0	24:05	107.5	52.5	30.0	24:10	108.0	53.0	30.0	24:15	108.5	53.5	30.0
24:20	108.0	53.0	30.0	24:25	108.5	53.5	30.0	24:30	109.0	54.0	30.0	24:35	109.5	54.5	30.0
24:40	109.0	54.0	30.0	24:45	109.5	54.5	30.0	24:50	110.0	55.0	30.0	24:55	110.5	55.5	30.0
25:00	110.0	55.0	30.0	25:05	110.5	55.5	30.0	25:10	111.0	56.0	30.0	25:15	111.5	56.5	30.0
25:20	111.0	56.0	30.0	25:25	111.5	56.5	30.0	25:30	112.0	57.0	30.0	25:35	112.5	57.5	30.0
25:40	112.0	57.0	30.0	25:45	112.5	57.5	30.0	25:50	113.0	58.0	30.0	25:55	113.5	58.5	30.0
26:00	113.0	58.0	30.0	26:05	113.5	58.5	30.0	26:10	114.0	59.0	30.0	26:15	114.5	59.5	30.0
26:20	114.0	59.0	30.0	26:25	114.5	59.5	30.0	26:30	115.0	60.0	30.0	26:35	115.5	60.5	30.0
26:40	115.0	60.0	30.0	26:45	115.5	60.5	30.0	26:50	116.0	61.0	30.0	26:55	116.5	61.5	30.0
27:00	116.0	61.0	30.0	27:05	116.5	61.5	30.0	27:10	117.0	62.0	30.0	27:15	117.5	62.5	30.0
27:20	117.0	62.0	30.0	27:25	117.5	62.5	30.0	27:30	118.0	63.0	30.0	27:35	118.5	63.5	30.0
27:40	118.0	63.0	30.0	27:45	118.5	63.5	30.0	27:50	119.0	64.0	30.0	27:55	119.5	64.5	30.0
28:00	119.0	64.0	30.0	28:05	119.5	64.5	30.0	28:10	120.0	65.0	30.0	28:15	120.5	65.5	30.0
28:20	120.0	65.0	30.0	28:25	120.5	65.5	30.0	28:30	121.0	66.0	30.0	28:35	121.5	66.5	30.0
28:40	121.0	66.0	30.0	28:45	121.5	66.5	30.0	28:50	122.0	67.0	30.0	28:55	122.5	67.5	30.0
29:00	122.0	67.0	30.0	29:05	122.5	67.5	30.0	29:10	123.0	68.0	30.0	29:15	123.5	68.5	30.0
29:20	123.0	68.0	30.0	29:25	123.5	68.5	30.0	29:30	124.0	69.0	30.0	29:35	124.5	69.5	30.0
29:40	124.0	69.0	30.0	29:45	124.5	69.5	30.0	29:50	125.0	70.0	30.0	29:55	125.5	70.5	30.0
30:00	125.0	70.0	30.0	30:05	125.5	70.5	30.0	30:10	126.0	71.0	30.0	30:15	126.5	71.5	30.0
30:20	126.0	71.0	30.0	30:25	126.5	71.5	30.0	30:30	127.0	72.0	30.0	30:35	127.5	72.5	30.0
30:40	127.0	72.0	30.0	30:45	127.5	72.5	30.0	30:50	128.0	73.0	30.0	30:55	128.5	73.5	30.0
31:00	128.0	73.0	30.0	31:05	128.5	73.5	30.0	31:10	129.0	74.0	30.0	31:15	129.5	74.5	30.0
31:20	129.0	74.0	30.0	31:25	129.5	74.5	30.0	31:30	130.0	75.0	30.0	31:35	130.5	75.5	30.0
31:40	130.0	75.0	30.0	31:45	130.5	75.5	30.0	31:50	131.0	76.0	30.0	31:55	131.5	76.5	30.0
32:00	131.0	76.0	30.0	32:05	131.5	76.5	30.0	32:10	132.0	77.0	30.0	32:15	132.5	77.5	30.0
32:20	132.0	77.0	30.0	32:25	132.5	77.5	30.0	32:30	133.0	78.0	30.0	32:35	133.5	78.5	30.0
32:40	133.0	78.0	30.0	32:45	133.5	78.5	30.0	32:50	134.0	79.0	30.0	32:55	134.5	79.5	30.0
33:00	134.0	79.0	30.0	33:05	134.5	79.5	30.0	33:10	135.0	80.0	30.0	33:15	135.5	80.5	30.0
33:20	135.0	80.0	30.0	33:25	135.5	80.5	30.0	33:30	136.0	81.0	30.0	33:35	136.5	81.5	30.0
33:40	136.0	81.0	30.0	33:45	136.5	81.5	30.0	33:50	137.0	82.0	30.0	33:55	137.5	82.5	30.0
34:00	137.0	82.0	30.0	34:05	137.5	82.5	30.0	34:10	138.0	83.0	30.0	34:15	138.5	83.5	30.0
34:20	138.0	83.0	30.0	34:25	138.5	83.5	30.0	34:30	139.0	84.0	30.0	34:35	139.5	84.5	30.0
34:40	139.0	84.0	30.0	34:45	139.5	84.5	30.0	34:50	140.0	85.0	30.0	34:55	140.5	85.5	30.0
35:00	140.0	85.0	30.0	35:05	140.5	85.5	30.0	35:10	141.0	86.0	30.0	35:15	141.5	86.5	30.0
35:20	141.0	86.0	30.0	35:25	141.5	86.5	30.0	35:30	142.0	87.0	30.0	35:35	142.5	87.5	30.0
35:40	142.0	87.0	30.0	35:45	142.5	87.5	30.0	35:50	143.0	88.0	30.0	35:55	143.5	88.5	30.0
36:00															



No.

DISTANCE

SPEED SPEED No. 4.

Inches
of H₂O.Feet
of air.Feet
of air. \sqrt{H} .Mean
velocity.

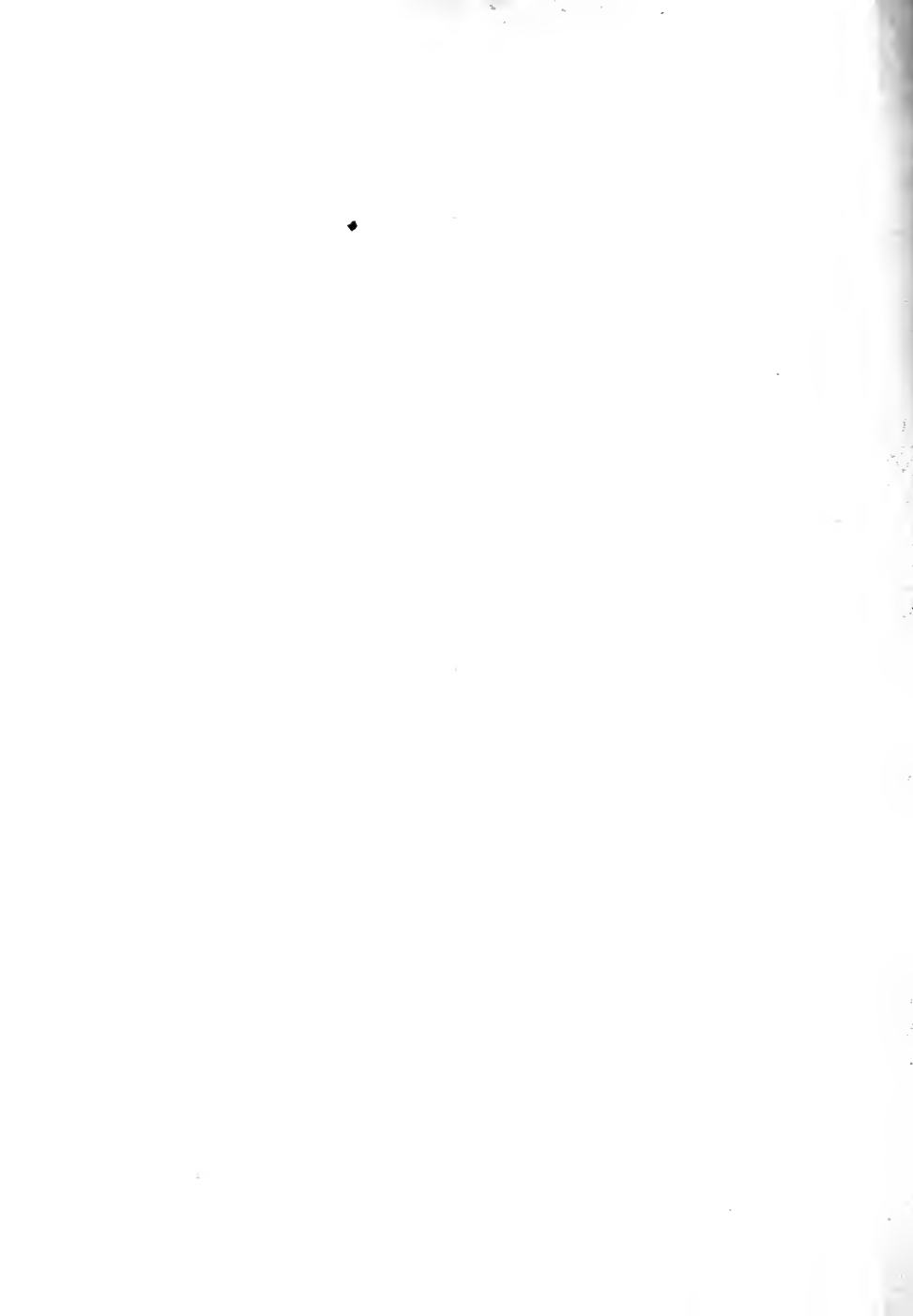
1	$\frac{1}{32}$	.15	10.50	1	49.90	7.06	56.70
2	$\frac{5}{32}$	.17	11.93	2	56.20	7.49	60.10
3	$\frac{7}{32}$	.21	14.75	3	64.60	8.03	64.50
4	$\frac{13}{32}$	.22	15.45	4	71.00	8.42	67.60
5	$\frac{17}{32}$.23	16.15	5	75.20	8.67	69.60
6	$\frac{21}{32}$.24	16.85	6	74.60	8.75	70.25
7	$\frac{25}{32}$.25	17.55	7	80.80	8.98	72.05

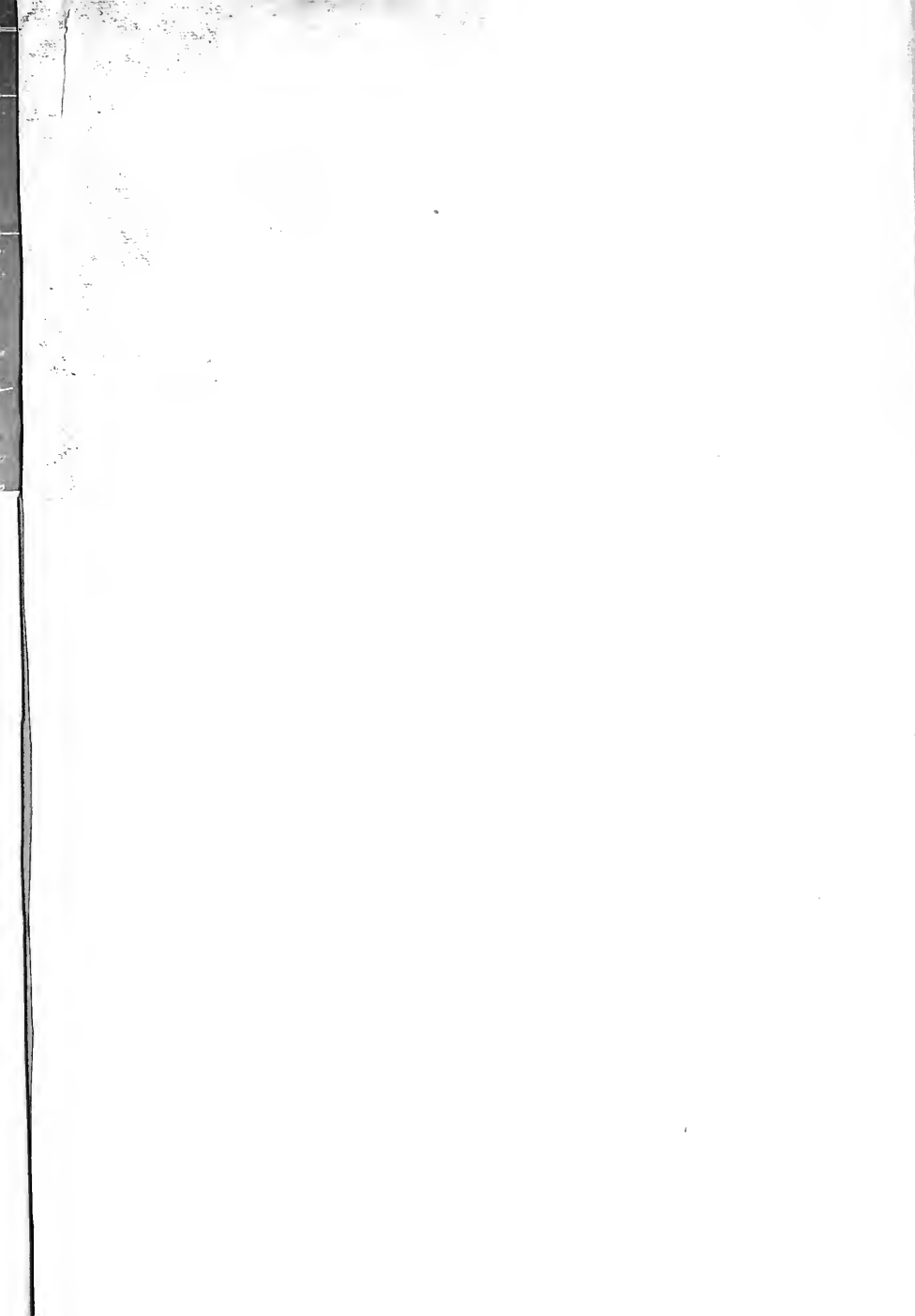
2. 10' 11" PIPE

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Run No 2 10" PIPE

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6444 NW 77th Pkwy

No. 1		No. 2		No. 3		No. 4		No. 5		No. 6		No. 7		No. 8		No. 9		No. 10		No. 11		No. 12		No. 13		No. 14		No. 15		No. 16		No. 17		No. 18		No. 19		No. 20		No. 21		No. 22		No. 23		No. 24		No. 25		No. 26		No. 27		No. 28		No. 29		No. 30		No. 31		No. 32		No. 33		No. 34		No. 35		No. 36		No. 37		No. 38		No. 39		No. 40		No. 41		No. 42		No. 43		No. 44		No. 45		No. 46		No. 47		No. 48		No. 49		No. 50		No. 51		No. 52		No. 53		No. 54		No. 55		No. 56		No. 57		No. 58		No. 59		No. 60		No. 61		No. 62		No. 63		No. 64		No. 65		No. 66		No. 67		No. 68		No. 69		No. 70		No. 71		No. 72		No. 73		No. 74		No. 75		No. 76		No. 77		No. 78		No. 79		No. 80		No. 81		No. 82		No. 83		No. 84		No. 85		No. 86		No. 87		No. 88		No. 89		No. 90		No. 91		No. 92		No. 93		No. 94		No. 95		No. 96		No. 97		No. 98		No. 99		No. 100	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																				

Rev. Mr. G. B. Byles

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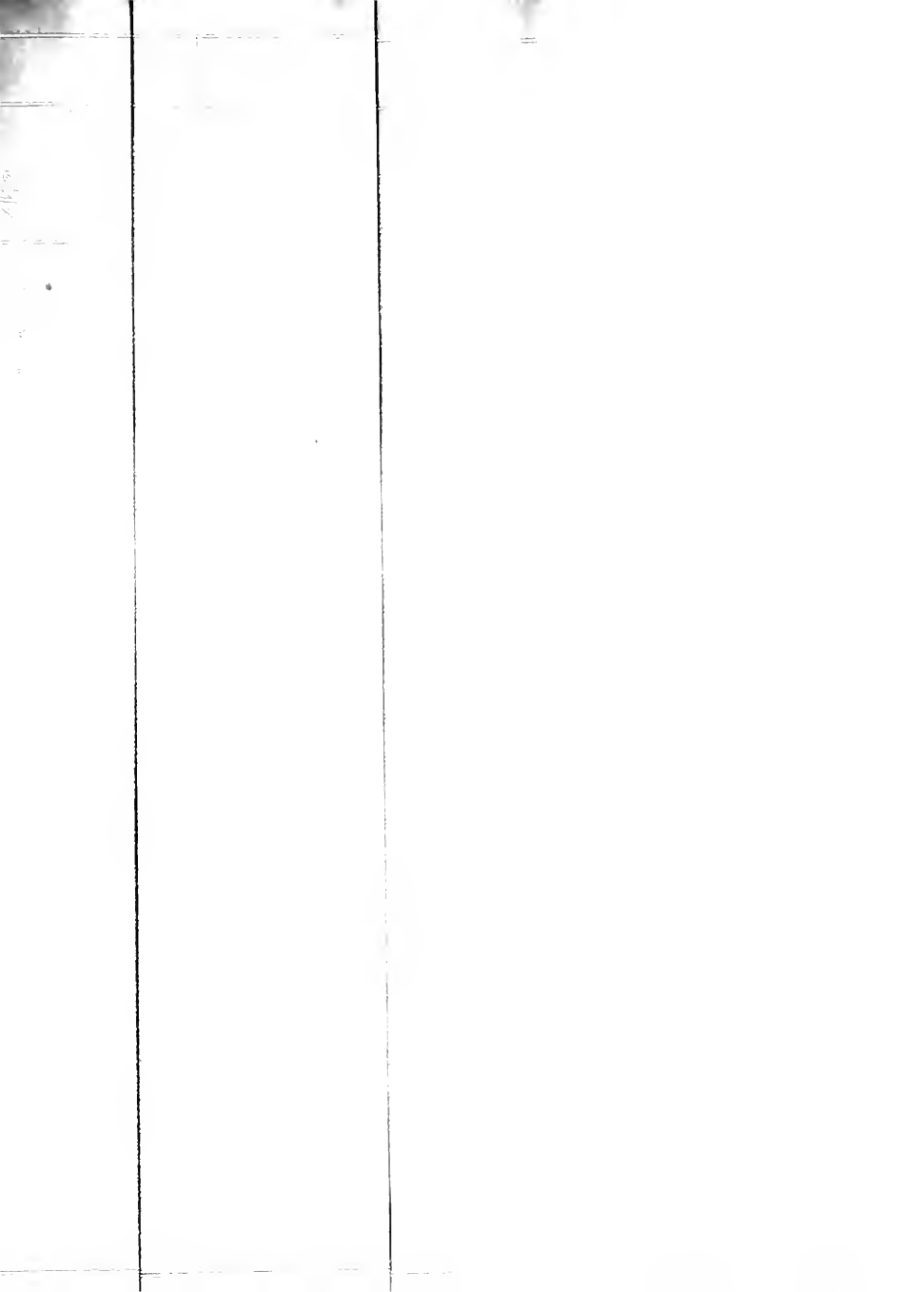
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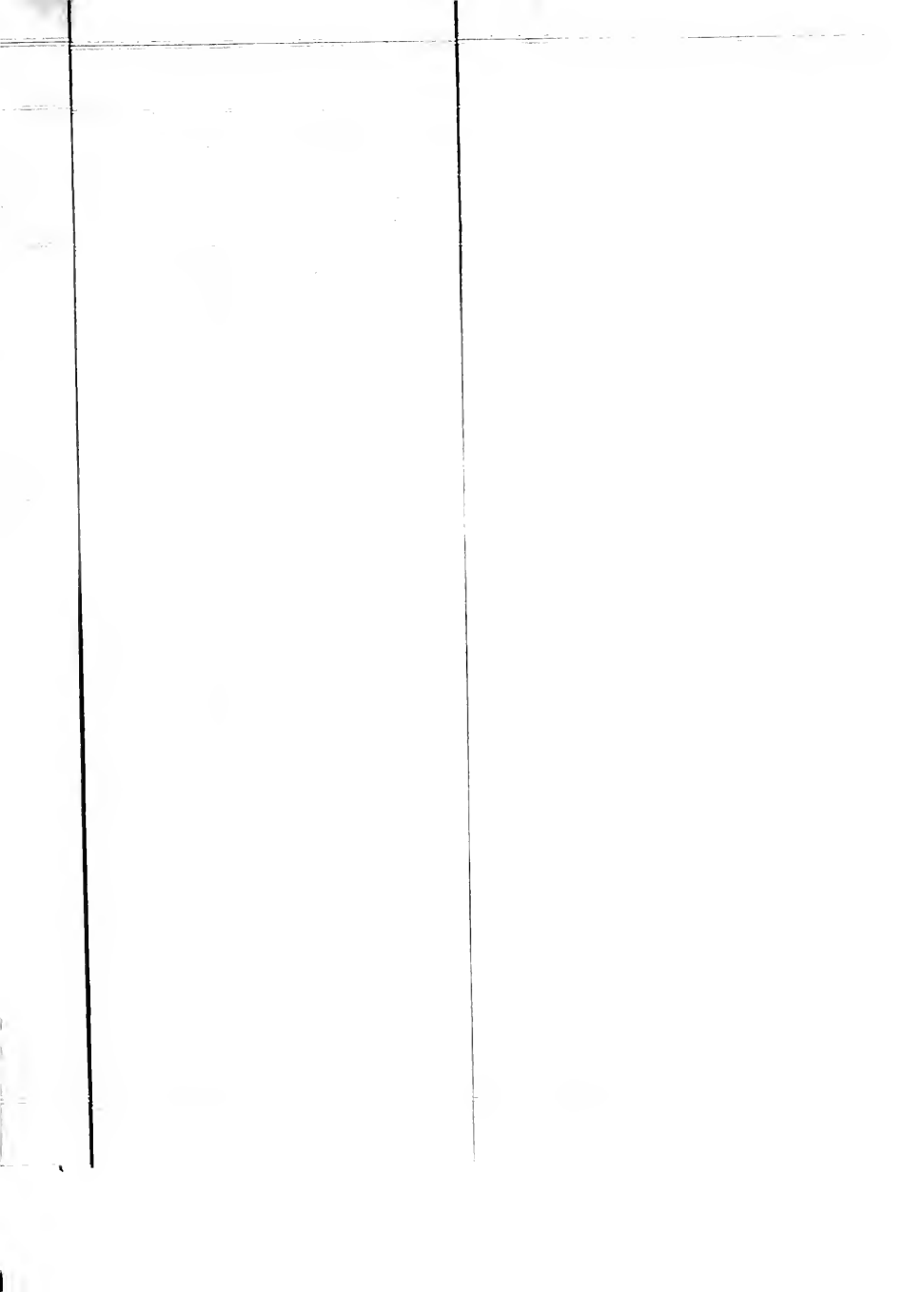


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Run No 2 "B" SPE																Run No 3 "B" SPE															
SPEED No 1				SPEED No 2				SPEED No 3				SPEED No 4				SPEED No 5				SPEED No 6				SPEED No 7							
Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure	Time	Speed	Altitude	Pressure
1	10.0	1000	1010	11.0	11.0	1100	1110	12.0	12.0	1200	1210	13.0	13.0	1300	1310	14.0	14.0	1400	1410	15.0	15.0	1500	1510	16.0	16.0	1600	1610	17.0	17.0	1700	1710
2	10.5	1050	1015	11.5	11.5	1150	1115	12.5	12.5	1250	1215	13.5	13.5	1350	1315	14.5	14.5	1450	1415	15.5	15.5	1550	1515	16.5	16.5	1650	1615	17.5	17.5	1750	1715
3	11.0	1100	1020	12.0	12.0	1200	1220	13.0	13.0	1300	1320	14.0	14.0	1400	1420	15.0	15.0	1500	1520	16.0	16.0	1600	1620	17.0	17.0	1700	1720	18.0	18.0	1800	1820
4	11.5	1150	1025	12.5	12.5	1250	1225	13.5	13.5	1350	1325	14.5	14.5	1450	1425	15.5	15.5	1550	1525	16.5	16.5	1650	1625	17.5	17.5	1750	1725	18.5	18.5	1850	1825
5	12.0	1200	1030	13.0	13.0	1300	1330	14.0	14.0	1400	1430	15.0	15.0	1500	1530	16.0	16.0	1600	1630	17.0	17.0	1700	1730	18.0	18.0	1800	1830	19.0	19.0	1900	1930
6	12.5	1250	1035	13.5	13.5	1350	1335	14.5	14.5	1450	1435	15.5	15.5	1550	1535	16.5	16.5	1650	1635	17.5	17.5	1750	1735	18.5	18.5	1850	1835	19.5	19.5	1950	1935
7	13.0	1300	1040	14.0	14.0	1400	1440	15.0	15.0	1500	1540	16.0	16.0	1600	1640	17.0	17.0	1700	1740	18.0	18.0	1800	1840	19.0	19.0	1900	1940	20.0	20.0	2000	2040
8	13.5	1350	1045	14.5	14.5	1450	1445	15.5	15.5	1550	1545	16.5	16.5	1650	1645	17.5	17.5	1750	1745	18.5	18.5	1850	1845	19.5	19.5	1950	1945	20.5	20.5	2050	2045
9	14.0	1400	1050	15.0	15.0	1500	1550	16.0	16.0	1600	1650	17.0	17.0	1700	1750	18.0	18.0	1800	1850	19.0	19.0	1900	1950	20.0	20.0	2000	2050	21.0	21.0	2100	2150
10	14.5	1450	1055	15.5	15.5	1550	1555	16.5	16.5	1650	1655	17.5	17.5	1750	1755	18.5	18.5	1850	1855	19.5	19.5	1950	1955	20.5	20.5	2050	2055	21.5	21.5	2150	2155
11	15.0	1500	1060	16.0	16.0	1600	1660	17.0	17.0	1700	1760	18.0	18.0	1800	1860	19.0	19.0	1900	1960	20.0	20.0	2000	2060	21.0	21.0	2100	2160	22.0	22.0	2200	2260
12	15.5	1550	1065	16.5	16.5	1650	1665	17.5	17.5	1750	1765	18.5	18.5	1850	1865	19.5	19.5	1950	1965	20.5	20.5	2050	2065	21.5	21.5	2150	2165	22.5	22.5	2250	2265
13	16.0	1600	1070	17.0	17.0	1700	1770	18.0	18.0	1800	1870	19.0	19.0	1900	1970	20.0	20.0	2000	2070	21.0	21.0	2100	2170	22.0	22.0	2200	2270	23.0	23.0	2300	2370
14	16.5	1650	1075	17.5	17.5	1750	1775	18.5	18.5	1850	1875	19.5	19.5	1950	1975	20.5	20.5	2050	2075	21.5	21.5	2150	2175	22.5	22.5	2250	2275	23.5	23.5	2350	2375
15	17.0	1700	1080	18.0	18.0	1800	1880	19.0	19.0	1900	1880	20.0	20.0	2000	1980	21.0	21.0	2100	2080	22.0	22.0	2200	2180	23.0	23.0	2300	2280	24.0	24.0	2400	2380
16	17.5	1750	1085	18.5	18.5	1850	1885	19.5	19.5	1950	1885	20.5	20.5	2050	1985	21.5	21.5	2150	2085	22.5	22.5	2250	2185	23.5	23.5	2350	2285	24.5	24.5	2450	2385
17	18.0	1800	1090	19.0	19.0	1900	1890	20.0	20.0	2000	1890	21.0	21.0	2100	1990	22.0	22.0	2200	1990	23.0	23.0	2300	2000	24.0	24.0	2400	2010	25.0	25.0	2500	2020
18	18.5	1850	1095	19.5	19.5	1950	1895	20.5	20.5	2050	1895	21.5	21.5	2150	1995	22.5	22.5	2250	2000	23.5	23.5	2350	2010	24.5	24.5	2450	2020	25.5	25.5	2550	2030
19	19.0	1900	1100	20.0	20.0	2000	1900	21.0	21.0	2100	1900	22.0	22.0	2200	2000	23.0	23.0	2300	2010	24.0	24.0	2400	2020	25.0	25.0	2500	2030	26.0	26.0	2600	2040
20	19.5	1950	1105	20.5	20.5	2050	1905	21.5	21.5	2150	1905	22.5	22.5	2250	2005	23.5	23.5	2350	2020	24.5	24.5	2450	2030	25.5	25.5	2550	2040	26.5	26.5	2650	2050
21	20.0	2000	1110	21.0	21.0	2100	1910	22.0	22.0	2200	1910	23.0	23.0	2300	2010	24.0	24.0	2400	2030	25.0	25.0	2500	2040	26.0	26.0	2600	2050	27.0	27.0	2700	2060
22	20.5	2050	1115	21.5	21.5	2150	1915	22.5	22.5	2250	1915	23.5	23.5	2350	2015	24.5	24.5	2450	2040	25.5	25.5	2550	2050	26.5	26.5	2650	2060	27.5	27.5	2750	2070
23	21.0	2100	1120	22.0	22.0	2200	1920	23.0	23.0	2300	1920	24.0	24.0	2400	2020	25.0	25.0	2500	2060	26.0	26.0	2600	2070	27.0	27.0	2700	2080	28.0	28.0	2800	2090
24	21.5	2150	1125	22.5	22.5	2250	1925	23.5	23.5	2350	1925	24.5	24.5	2450	2025	25.5	25.5	2550	2070	26.5	26.5	2650	2080	27.5	27.5	2750	2090	28.5	28.5	2850	2100
25	22.0	2200	1130	23.0	23.0	2300	1930	24.0	24.0	2400	1930	25.0	25.0	2500	2030	26.0	26.0	2600	2080	27.0	27.0	2700	2090	28.0	28.0	2800	2100	29.0	29.0	2900	2110
26	22.5	2250	1135	23.5	23.5	2350	1935	24.5	24.5	2450	1935	25.5	25.5	2550	2035	26.5	26.5	2650	2090	27.5	27.5	2750	2100	28.5	28.5	2850	2110	29.5	29.5	2950	2120
27	23.0	2300	1140	24.0	24.0	2400	1940	25.0	25.0	2500	1940	26.0	26.0	2600	2040	27.0	27.0	2700	2100	28.0	28.0	2800	2110	29.0	29.0	2900	2120	30.0	30.0	3000	2130
28	23.5	2350	1145	24.5	24.5	2450	1945	25.5	25.5	2550	1945	26.5	26.5	2650	2045	27.5	27.5	2750	2110	28.5	28.5	2850	2120	29.5	29.5	2950	2130	30.5	30.5	3050	2140
29	24.0	2400	1150	25.0	25.0	2500	1950	26.0	26.0	2600	1950	27.0	27.0	2700	2050	28.0	28.0	2800	2120	29.0	29.0	2900	2130	30.0	30.0	3000	2140	31.0	31.0	3100	2150
30	24.5	2450	1155	25.5	25.5	2550	1955	26.5	26.5	2650	1955	27.5	27.5	2750	2055	28.5	28.5	2850	2130	29.5	29.5	2950	2140	30.5	30.5	3050	2150	31.5	31.5	3150	2160
31	25.0	2500	1160	26.0	26.0	2600	1960	27.0	27.0	2700	1960	28.0	28.0	2800	2060	29.0	29.0	2900	2140	30.0	30.0	3000	2150	31.0	31.0	3100	2160	32.0	32.0	3200	2170
32	25.5	2550	1165	26.5	26.5	2650	1965	27.5	27.5	2750	1965	28.5	28.5	2850	2065	29.5	29.5	2950	2150	30.5	30.5	3050	2160	31.5	31.5	3150	2170	32.5	32.5	3250	2180
33	26.0	2600	1170	27.0	27.0	2700	1970	28.0	28.0	2800	1970	29.0	29.0	2900	2070	30.0	30.0	3000	2160	31.0	31.0	3100	2170	32.0	32.0	3200	2180	33.0	33.0	3300	2190
34	26.5	2650	1175	27.5	27.5	2750	1975	28.5	28.5	2850	1975	29.5	29.5	2950	2075	30.5	30.5	3050	2170	31.5	31.5	3150	2180	32.5	32.5	3250	2190	33.5	33.5	3350	2200
35	27.0	2700	1180	28.0	28.0	2800	1980	29.0	29.0	2900	1980	30.0	30.0	3000	2080	31.0	31.0	3100	2180	32.0	32.0	3200	2190	33.0	33.0	3300	2200	34.0	34.0	3400	2210
36	27.5	2750	1185	28.5	28.5	2850	1985	29.5	29.5	2950	1985	30.5	30.5	3050	2085	31.5	31.5	3150	2190	32.5	32.5	3250	2200	33.5	33.5	3350	2210	34.5	34.5	3450	2220
37	28.0	2800	1190	29.0	29.0	2900	1990	30.0	30.0	3000	1990	31.0	31.0	3100	2090	32.0	32.0	3200	2200	33.0	33.0	3300	2210	34.0	34.0	3400	2220	35.0	35.0	3500	2230
38	28.5	2850	1195	29.5	29.5	2950	1995	30.5	30.5	3050	1995	31.5	31.5	3150	2095	32.5	32.5	3250	2210	33.5	33.5	3350	2220	34.5	34.5	3450	2230	35.5	35.5	3550	2240
39	29.0	2900	1200	30.0	30.0	3000	2000	31.0	31.0	3100	2000	32.0	32.0	3200	2100	33.0	33.0	3300	2220	34.0	34.0	3400	2230	35.0	35.0	3500	2240	36.0	36.0	3600	2250
40	29.5	2950	1205	30.5	30.5	3050	2005	31.5	31.5	3150	2005	32.5	32.5	3250	2105	33.5	33.5	3350	2230	34.5	34.5	3450	2240	35.5	35.5	3550	2250	36.5	36.5	3650	2260
41	30.0	3000	1210	31.0	31.0	3100	2010	32.0	32.0	3200	2010	33.0	33.0	3300	2110	34.0	34.0	3400	2240	35.0	35.0	3500	2250	36.0	36.0	3600	2260	37.0	37.0	3700	2270
42	30.5	3050	1215	31.5	31.5	3150	2015	32.5	32.5	3250	2015	33.5	33.5	3350	2115	34.5	34.5														



Run No. 104 4' Pipe																	Run No. 105 3' Pipe																
SPEED No. 1				SPEED No. 2				SPEED No. 3				SPEED No. 4				SPEED No. 1				SPEED No. 2				SPEED No. 3				SPEED No. 4					
Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks	Time	Distance	Speed	Remarks		
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00		
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00		
4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00		
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00		
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7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00		
8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00		
9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00		
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11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00		
12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00		
13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00		
14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00		
15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00		
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00		
17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00		
18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00		
19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00		
20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00		
21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00		
22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00		
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00		
24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00		
25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00		
26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00		
27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00	27.00		
28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00		
29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00		
30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00		
31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00		
32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00		
33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00		
34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00		
35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00		
36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00		
37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00		
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